EFFECT OF FOLIAR APPLICATION OF WATERSOLUBLE FERTILIZERS ON GROWTH AND YIELD OF MAIZE

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ABSTRACT

Maize (*Zea mays* L.) has high yield potential. Its productivity depends mainly upon nutrient management. Appropriate timing with effective fertilizer application methods improves maize response to fertilizer through nutrients supplement and reduction of nutrient loss. Therefore, the effect of foliar application of water soluble fertilizers (WSF) on growth and yield of maize was conducted in University of Agricultural Sciences, GKVK, Bengaluru in *Kharif* in 2015.Two levels (75% and 100%) of recommended dose of fertilizer (RDF) 150: 75: 40 kg NPK ha^{-1} were applied to soil in combination with foliar spray of water soluble NPK (19:19:19) at 0.5% concentration sprayed at critical growth stages. Soil application alone orT_7: (RDF) 150: 75: 40 kg NPK ha^{-1}was the control. The results showed significant increase of kernel yield (22.8%) with 100% RDF soil application, followed by 0.5% foliar spray of water soluble fertilizer at critical growth stages over the control. The increase of maize yield was expressed by better biological yield and economic yield components viz, total dry matter accumulation (468 g), cob weight (211.90 g), cob length (18.53 cm), number of kernel rows per cob (17.27), number of kernels per row (35.13) and kernel weight per plant (171.23 g per plant). Soil application of RDF followed by water soluble fertilizer spray at 0.5% (19: 19: 19 NPK) at 6 leaf growth stage knee height and tasseling stage recorded significantly higher kernel yield over other treatments. Significantly higher kernel yield of (9361 kg ha^{-1}) was recorded from plots treated with 100% RDF through soil application followed by foliar spray of water-soluble fertilizers (WSF) at 6 leaf growth stage and tasseling stage compare to the control plots treated with T_7: (RDF) 150: 75: 40 kg NPK ha^{-1}; where yield of 7223 kg ha^{-1} was obtained. This results in yield increase of 22.8% over the control. Higher net returns in rupees (Rs. 72500 ha^{-1}) and B: C (cost benefit ratio)of 2.8 were also recorded with 100 % RDF followed by 0.5 % foliar spray of water soluble fertilizers at 6 leaf growth stage and tasseling stage whereas the lower net returns (Rs.49844 ha^{-1}) with B: C of 2.3 compare to other treatments which could be adopted in maize cultivation for higher kernel yield and economic returns.

Key words: Maize, foliar application, NPK levels, yield

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INTRODUCTION

Maize (*Zea mays* L.) is known as "Queen of cereals" due to its high yield potential among the cereals, it is one of the important cereal crops next to wheat and rice in the world. Maize kernels, are gaining importance as a commercial and industrial crop.The area and production of maize crop in India (Karnataka state) is increasing year by year due to its high demand as animal and poultry feed and also ease of cultivation because it is less susceptible to pest and diseases in this region. The average of productivity is 2883 kg ha^{-1} (Anon., 2014) against 4890 kg ha^{-1} global productivity. Maize crop beside to its great production potential, it has a wide range of adaptability to environments conditions ranging from tropical to temperate regions and geographically it is grown from 58^{o} N to 40^{o} S, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rainfall per year.

Maize is an exhaustive crop and its productivity depends on many factors including nutrient management, soil management, water management, changes in soil quality, and availability of mineral fertilizers, changes in temperature and precipitation conditions (David and Sharon.2012). Timely application of major nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements of crops such as rapid and efficient response by crops. Modern agriculture must supply crops with optimal rates of nutrients throughout the growth cycle in the most efficient manner and without degrading soil and water resources. This can be achieved through adoption of modern practices in terms of nutrient management particularly fertilizers which are fully water soluble, solid or liquid fertilizers having high content of primary nutrients with low salt index. They may have secondary nutrients and micronutrients. These water-soluble fertilizers can be used for foliar feeding and fertigation of crops. Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture especially under moisture limited situation. This method provides for utilization of nutrients more efficiently for correcting deficiencies rapidly.

The primary objective of foliar application is to allow foliar fertilizer enhancing absorption of nutrients by the plant and therefore maximizing their utilization.NPK fertilizers that are water soluble are most suitable for this purpose. Apply a balanced fertilizer in critical stages of growth will give greater benefit level and quality of agricultural production (Dobrinoiu and Dumbrava, 2003). Foliar feeding is an effective method for correcting nutrients deficiencies and overcoming the soil's inability to transfer nutrients to the maize plant under low moisture conditions (Stigler *et al*., 2010). Foliar application is usually preferred because very small amounts of fertilizers are applied per unit area and decrease ground water pollution. Application of NPK at 1 percent concentration twice at 30 and 60 days after emergence (DAE) produced the highest single leaf area (415.0 cm^2) when compared with other application timings (Amanullah *et al*., 2010). Many investigators concluded that foliar application of nutrients sources during growth stage increased grain and straw yields (Parvez *et al*., 2009, Yassen *et al*., 2010 and Ahmed, *et al*., 2011).According to Abd El-Fattah *et al*., 2012, research revealed that foliar application of NPK fertilizers has positive impact on maize yield parameters over soil application.

Amanullah *et al*. (2010) reported that application of N+P+K produced the maximum biological yield (11333 kg ha^{-1}) followed by N + P (10761 kg ha^{-1}); while the lowest biological yield (9740 kg ha^{-1}) was obtained when K was sprayed alone. Application of nutrients in two equal splits (1% each at 30 and 60 DAE) increased the biological yield to maximum (10638 kg ha^{-1}) while application of nutrients (2%) at 30 DAE decreased the biological yield to minimum (9895 kg ha^{-1}). Azhar *et al*. (2011) conducted field experiment to evaluate the integrated nutrients effect on growth, yield and quality of maize (*Zea mays* L.). The results revealed that biological yield of maize plants varied from maximum of 15.73 t ha^{-1} (attained in treatment received recommended NPK at 200- 120-125 kg ha^{-1} + single spray of multi-nutrientat1.25 L ha^{-1}) to minimum 2.707 t ha^{-1}was recorded in control plot (without treatment). Whereas, the maximum value of biological yield 13.750 t ha^{-1} and 12.460 t ha^{-1}, respectively in the treatments receiving recommended dose of fertilizer at 200-120-125 kg NPK ha^{-1}) and recommended NPK at 200-120-125 kg ha^{-1} + two spraying of multi-nutrient at 1.25 L ha^{-1} and were statistically at par with each other.

Abd EL- Fattah *et al*. (2012) reported that the maximum values of ear weight, 100 grain weight and number of rows as well as ear length of maize were 356.65 g, 13.82 g, 13.42 and 20.84 cm respectively with foliar application of NPK fertilizers. On the other hand, the lowest values of the above-mentioned parameters were 336.15 g, 13.08 g, 12.67 and 17.42 cm, respectively occurred with soil application. Asif *et al*. (2013) conducted a field experiment to study the impact of different levels of nitrogen and zinc sulphate on the phenology, yield and quality of maize. The results showed that nitrogen and zinc sulphate application significantly affected the growth, yield and quality parameters of maize. Maximum days to 50 percent silking were recorded at 300 kg N level. Minimum number of days for 50 per cent completion of silking was recorded in application of 27 kg $ZnSO_4$. The minimum days to 50 percent silking (44.3 and 48.3) along with maximum plant height (242.3 cm), number of grains per cob (539.6), 1000-grain weight (316.0g), grain yield (7.9 t ha^{-1}) and protein contents (9.9%) were noted in 300 kg N + 27 kg $ZnSO_4$. These results indicated that these traits linearly increased with increasing levels of N and $ZnSO_4$ up to their maximum rate.

Amanullah *et al.* (2014) showed that nutrient combination, application time and interaction had significant effects on maize grain yield. Combined application of N + P + K produced the maximum grain yield (3287 kg ha^{-1}), followed by N + P (3187 kg ha^{-1}); while the lowest grain yield (2547 kg ha^{-1}) was obtained when K was sprayed alone. Application of nutrients in two equal splits (1% each at 30 and 60 DAE) increased the grain yield to maximum (3067 kg ha^{-1}), while application of nutrients (2%) at 30 DAE decreased the grain yield to minimum (2795 kg ha^{-1}). The interaction between foliar nutrients and their application time indicated that sole N application at 2 per cent at 30 DAE decreased the grain yield significantly. Whereas, combined foliar application of N+P or N+P+K (2% at 60 DAE) or (1% both 30 and 60 DAE) increased the maize grain yield significantly. The aim of this investigation was to study the effect of foliar application of water soluble fertilizers on growth and yield of maize.

Materials and methods

The study was conducted during *Kharif* season of 2015 at Agronomy Field Unit, Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi KrishiVignan Kendra, Bengaluru, which is located in Eastern Dry Zone of Karnataka at 12^0 58' north latitude and 77^0 35' East longitude with an altitude of 930 m above mean sea level. The soil was red sandy clay loam with neutral in reaction (pH 6.9) and the electrical conductivity was normal (0.32 dSm^{-1} at 25 °C), medium organic carbon (0.65 %), available nitrogen was medium (386.4 kg ha^{-1}), available phosphorus was high (69.3 kg ha^{-1}) and medium available potassium (291.53 kg ha^{-1}). The experiments was laid out in randomized complete block design and comprised of seven treatments replicated thrice as follows: **T_1:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage, **T_2:** 100 % RDF + WSF spray at0.5 % concentration at tasseling stage, **T_3:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_4:** 75 % RDF + WSF at 0.5 % concentration at 6 leaf growth stage, **T_5:** 75 % RDF + WSF spray at 0.5 % concentration at tasseling stage, **T_6:** 75 % RDF + WSF spray at 0.5 % concentration at 6 leaves growth stage and tasseling stages,T_7: control (RDF) 150: 75: 40 kg NPK ha^{-1}.

Rainfall during cropping period (July-November) was 586.84 mm as against the normal of 550.6 mm which was higher by 36.2 mm and was well distributed during crop growth period except in August i.e. during early growth period. The mean maximum temperature recorded during the period of crop growth was in the range of 29.3 ºC (August) to 25.3 ºC (November). The maximum temperature during crop growing period was more or less similar to Normal with a deviation of (-1.4 ºC) (meteorological data from Zonal Agricultural Research Station, GKVK, UAS, Bengaluru, July-November 2015). The recommended dose of fertilizer (RDF) was applied in each plot to treatments wise in the form of urea, single super phosphate and muriate of potash, respectively. Sowing was done on 29 July, 2015 the maize seeds varieties Hema (NAH-1137); the hybrid matures in 115 to 125 days. It is resistant to turcicum leaf blight and downy mildew. Seeds were hand drilled in rows in plots of 6.0 cm length and 5.1 cm with total area of 30.6 m^2, the net plot size was 4.8 m by 4.5 m, spacing was 60 cm x 30 cm, drip irrigation method was used. The other practices of growing maize were properly taken for the management of experimental plots throughout the cropping season. Five plants from net plot area were randomly selected and observations on growth and yield parameters, which were recorded at 30, 60, 90 DAS and at harvest. The observation on plant height in centimeter was done by using a scale from in it base to tip of the fully opened top leaf, no. of green leaves per plant was counted from five randomly selected plants in each treatment and the mean was computed and expressed in number of green leaves per plant, leaf area per plant was determined by collecting green leaves and passed through "LICOR-3100 Leaf area meter" for reading leaf area and expressed as cm^2 per plant, leaf area index (LAI) was worked out by dividing the leaf area per plant by land area occupied by the plant (Watson, 1952), leaf area index (LAI) was worked out by dividing the leaf area per plant by land area occupied by the plant (Watson, 1952), leaf chlorophyll content of plant was measured at 30, 60 and 90 DAS by using "SPAD 502 plus" designed at LICOR, Ins., total dry matter accumulation was determined by measuring above ground portion plant sample subjected into air oven at 65^o C for 72 hrs. using weighing balance and express in gram per plant. The yield parameters were recorded on five cobs and mean taken for each observation. The length of cob was measured from the base to tip by using scale and expressed in centimeter, cob diameter was recorded by using slide calipers in cob at the base, middle and top of five cobs and mean diameter of cob was expressed in centimeter, the weight cob after drying (at 12 per cent moisture) by using weighing balance and expressed in grams per cob, the number of kernels per row was counted from each of five cobs and average was expressed as number of kernels per row, the number of rows per cob was counted from each of five cobs and average was expressed as number of rows per cob, Kernel weight per plant was determined after shelling by using weighing balance,100 kernel weight in grams were randomly selected from the kernels of five labeled plants and weight was measured with weighing balance.

The kernel yield per hectare was obtained by measuring the net plot area yield after drying under shade till moisture content reach 12 per cent and recorded in kilograms using weighing balance and obtained yield extrapolated in kilogram per hectare. The Stover yield for each net plot was recorded after drying and yield per hectare was calculated and expressed in kilogram per hectare (kg ha^{-1}). The data were analyzed statistically for test of significance. The level of significance on "F" test was tested at 5 per cent. The interpretation of data was done by using CD values calculated at $p \geq 0.05$ (Gomez and Gomez, 1984) and PROC MIXED procedure based on the mixed linear model of SAS (version 9.4; SAS Institute, Cary, NC). Fisher's protected least significant difference (LSD) test at 0.05 probability level was used to detect differences between treatment means.

Results and discussion

Effect of foliar application of water-soluble fertilizers on growth parameters

The maize crop growth and yield were statistically significant higher with the plots imposed by 100% RDFs followed by foliar spray at 0.5% twice; at 6 leaves and tasseling growth stage, the statistically significantly lower were observed in plots under soil treatment with RDF alone as well as 75% RDF combined with one foliar spray at 6 leaves growth stage.

The presented data (Table 1, 2 and 3) showed that foliar application of water-soluble fertilizers significantly increased plant height, number of green leaves, leaf area, leaf area Index, chlorophyll content and dry matter production. There was significant effect on the aforementioned growth attributes. Significantly higher plant height of (231.80, 245.60 and 247.23 cm) was recorded in treatment of 100 % RDF along with twice foliar spray at 6 leaf growth stage and tasseling stages at 60, 90 DAS and at harvest respectively as compared to soil application of RDF. In adversely, the significantly lower plant height of (184.77, 199.70 and 210.20 cm) was noticed with soil application at 75 % RDF along with one spray of WSF at 0.5 % concentration at 6 leaf growth stage at the aforesaid stages. With respect to the growth stage at 30, 60 and 90 DAS the treated plots with 100%RDF + two foliar application at plant with 6 leaves growth stage and tasseling stage had registered high number of green leaves (5.76, 14.60 and 15.80) and high leaf area of (2639, 9159 and 10989 cm^2) compare to the control plot where lower number of green leaves (5.60, 12.20 and 9.70) and leaf area (2384, 7579 and 9095 cm^2)were recorded. The same trend was observed on leaf area index (1.46, 5.08 and 6.10 with respect to day wise) noticed with soil application of 100% RDF followed by WSF at 6 leaves growth stage and tasseling stage over control, except at 30 DAS where non-significant results were observed. Plant height at 30 DAS, was not varied significantly among of treatments. However, foliar application of water soluble NPK fertilizers had significant influence on plant height of maize at 60 and 90 DAS.At60 DAS and 90 DAS significantly higher plant height (231.80 cm and 245.60 cm, respectively) were observed in the plots treated with 100% RDF followed by WSF at 0.5% at 6 leaves growth stage and tasseling stage**,** the above-mentioned results were on par with ones (218.57 cm and 225.87 cm respectively to day wise) from treatment of 100% followed by one foliar spray at tasseling stage. Significantly lower plant height (197 cm and 200.57 cm, with respect to day wise) were recorded in control treatment. The significant difference noticed in plant height and leaf area (Table 1 and 2) at 60 and 90 days may be due to balanced crop nutrition which lead to rapid division and elongation of cells resulting in improved plant height which resulted in a greater number of leaves, these results are in concordance with Provez *et al.* (2009).Non-significant results noticed in aforementioned parameters at 30 days was due to slow uptake of nutrients by maize during early growth stage. The increase in leaf area and LAI (Table 3) could also be due to increased plant height and number of leaves. All these factors combined together caused increase in dry matter production and its accumulation in fruiting parts (sink) and finally the yield. These results were in concordance with Amanullah *et al.* (2010).

Table 1: Plant height and number of green leaves as influenced by foliar spray of water soluble fertilizers

T	Plant height (cm)				Number of green leaves			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	33.00	209.87	216.37	217.43	5.67	13.53	11.90	7.53
T_2	33.00	218.57	225.87	226.70	5.50	13.87	14.43	8.37
T_3	35.00	231.80	245.60	247.23	5.76	14.60	15.80	10.40
T_4	30.07	184.77	199.70	210.20	4.53	11.53	8.20	6.63
T_5	30.10	210.67	211.84	212.54	4.83	12.43	11.30	7.47
T_6	32.43	197.00	218.20	223.57	5.13	13.63	13.43	8.00
T_7	31.73	8.03	209.57	211.17	5.60	12.20	9.70	6.87
S.Em ±	1.51	8.03	7.97	6.96	0.31	0.61	0.58	0.51
CD (P=0.05)	NS	24.74	24.57	21.44	NS	1.89	1.77	1.58
CV (%)	8.12	6.71	6.33	5.45	10.10	8.10	8.23	11.22

T_1: 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage, **T_2:** 100 % RDF + WSF spray at0.5 % concentration at tasseling stage, **T_3:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_4:** 75 % RDF + WSF at 0.5 % concentration at 6 leaf growth stage, **T_5:** 75 % RDF + WSF spray at 0.5 % concentration at tasseling stage, **T_6:** 75 % RDF + WSF spay at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_7:** RDF (150: 75: 40 kg NPK ha^{-1}).

Chlorophyll content in leaf through SPAD readings indicated significantly differences among treatments to all growth stage. This difference ranged from 15.9 to 9.9 at final stage. Treatment of soil application 100 % RDF coupled with foliar spray twice at 6 leaf growth stage and tasseling stage registered higher chlorophyll content (29.8, 36.8 and 15.7 mg g^{-1} at 30, 60 and 90 DAS, respectively) over soil application of RDF(26.7, 29.6 and 10.3 mg g^{-1},corresponding to period mentioned). The least means (19.4, 27.7, and 9.9 mg g^{-1} at 30. 60 and 90 DAS, respectively) were noticed with 75% RDF along with single spray at 6 leaf growth stage. This clearly indicates that foliar application of NPK fertilizers helps in development of more leaf area and that lead to production of more chlorophyll.

Table 2: Leaf area and leaf area index as influenced by foliar spray of water-soluble fertilizers

Treatments	Leaf area (cm^2)			Leaf area index		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1: 100 % RDF + WSF at 6 leaf growth stage	2438	8323	9515	1.35	4.62	5.39
T_2: 100 % RDF + WSF at tasseling stage	2481	8611	10333	1.38	4.78	5.73
T_3: 100 % RDF + WSF knee height + tasseling stage	2639	9158	10989	1.46	5.08	6.10
T_4: 75 % RDF + WSF at 6 leaf growth stage	2270	7162	8061	1.26	3.97	4.47
T_5: 75 % RDF + WSF at tasseling stage	2277	7912	9494	1.26	4.39	5.27
T_6: 75 % RDF + WSF at 6 leaf growth stage + tasseling stage	2345	8284	9941	1.30	4.60	5.52
T_7: RDF (150: 75: 40 kg NPK ha^{-1})	2384	7579	90951	1.32	4.20	5.05
S. Em ±	111	380	473	0.06	0.21	0.26
CD (P=0.05)	NS	1172	1458	NS	0.65	0.81
CV (%)	8.02	8.09	8.5	8.23	8.10	8.49

Statistically high mean of total dry matter production was recorded at 0.5 % WSF spray twice at 6 leaf growth stage and tasseling stage along with 100 % RDF to the rate of 164.7, 403.2 and 468 g at 60, 90 DAS and at harvest over soil application RDF only. Nevertheless, the lower mean (112.9, 306.3 and 357 g at 60, 90 DAS and harvest respectively) were noticed with 75 % RDF plus one foliar spray at 6 leaf growth stage (Table 3). This was probably due to high assimilation of NPK of foliar application which reduced N losses and played a role in building up protoplasm, amino acids and proteins which induced cell division and initiate meristematic activity, which led to high plant height, a greater number of leaves and leaf area as well as leaf area index. These results are in harmony with (Yuncai *et al.,* 2008)

Table 3: Chlorophyll content and total dry matter as influenced by foliar spray of water-soluble fertilizers

Treatments	Chlorophyll content (mg g^{-1})			Total dry matter accumulation (g)		
	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At harvest
T_1: 100 % RDF + WSF at 6 leaf growth stage	27.8	33.2	11.6	129.5	338.3	408
T_2: 100 % RDF + WSF at tasseling stage	28.0	34.7	13.1	143.4	370.3	423
T_3: 100 % RDF + WSF knee height + tasseling stage	29.8	36.8	15.7	164.7	403.2	468
T_4: 75 % RDF + WSF at 6 leaf growth stage	19.4	27.7	9.9	112.9	306.3	357
T_5: 75 % RDF + WSF at tasseling stage	20.7	30.7	11.2	123.2	323.4	386
T_6: 75 % RDF + WSF at 6 leaf growth stage + tasseling stage	19.5	34.0	12.5	139.7	355.5	409
T_7: RDF (150: 75: 40 kg NPK ha^{-1})	26.7	29.6	10.3	122.3	317.4	385
S.Em ±	1.4	1.8	0.7	6.35	16.57	19
CD (P=0.05)	4.3	5.5	2.3	19.58	51.05	57
CV (%)	9.9	9.6	10.7	8.23	8.32	8.1

Effect of foliar spray of water-soluble fertilizers on yield and its components

As illustrated in table 4, the obtained results indicated that there is significant difference among means of yield and its components *viz*, cob weight, cob length, cob diameter, number of kernel rows cob^{-1}, number of kernels rows^{-1}, kernel weight plant^{-1}, kernel yield ha^{-1}, stover yield ha^{-1}, harvest index as influenced by foliar application of water soluble fertilizers except 100 kernel weight. The data in the same table indicated that higher cob weight, cob length, cob diameter, number of kernel rows cob^{-1}, number of kernels rows^{-1}as well as kernel weight per plant(211.90 g, 18.53 cm, 12.51 cm, 17.27, 35.13 and 171.23g respectively) were recorded at 100 % RDF along with two foliar spray of WSF at 6 leaf growth stage and tasseling stage over the soil application with RDF alone. Contrary, lowest values of the aforementioned attributes were (163.30 g,14.85 cm, 10.35 cm, 15.07, 32.03, 129.17 g and 26.17 g) occurred with soil application of 75 % RDF with single spray of WSF at 6 leaf growth stage recorded. This increase in yield components was mainly due to high dry matter production and its partition in fruiting parts which in turns give significantly high yield. Similar results were reported by Abd EL-Fattah *et al.* (2012) in maize and also Hasina *et al.* (2011) in wheat.

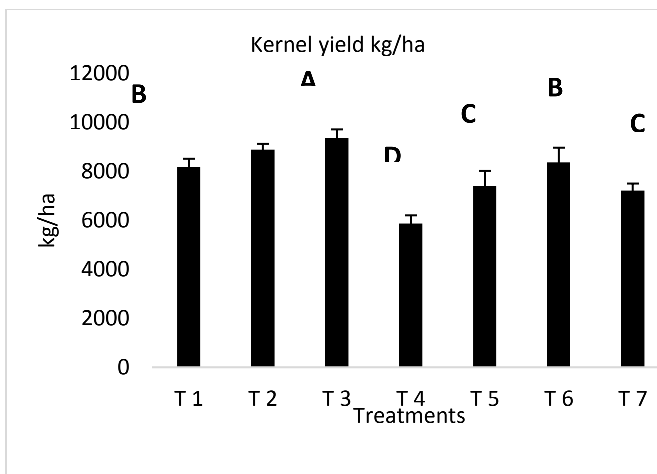
Figure 1proved the importance of the additional of foliar application after soil application of recommended dose of fertilizer maize kernel yield. The significantly higher of the above-mentioned yield (9361 kg ha^{-1})were recorded with 100 % RDF together with WSF spray twice at 6 leaf growth stage and tasseling stage. This result was on par with those obtained from the plot treated with 100% RDF followed by foliar application at 0.5% at tasseling stage (8883kg ha^{-1}). The significantly lower yield was noticed in control T_7: (RDF) 150: 75: 40 kg NPK ha^{-1})(7223 ha^{-1}).The stover (Figure 2) yield was statistically different due to foliar application , significantly higher stover yield (15505 kg ha^{-1}) was recorded in plot received 100 % RDF along with two foliar spray of WSF at 6 leaf growth stage and tasseling stage. The significantly lower stover yield (12457 kg ha^{-1})was obtained from T4(75% RDF followed single foliar spray of WSF at 6 leaf growth stage. This high yielding ability was due to higher yield components resulted in this treatment which gave rise higher kernel yield and higher dry matter produced during different growth stages. The results of present findings are in line with Asghar *et al.* (2011).

Table 4: Cob weight, cob length, cob diameter, no. of kernel rows cob^{-1}, no. of kernels rows^{-1}, kernel weight plant^{-1}, 100 kernel weight as influenced by foliar spray of water-soluble fertilizers

T	Cob weight (g)	Cob length (cm)	Cob diameter (cm)	No.of kernel rows cob^{-1}	No.of kernels rows^{-1}	Kernel weight plant^{-1} (g)	100-kernel weight (g)
T_1	183.17	15.92	10.64	15.40	32.00	137.58	28.04
T_2	195.70	17.03	11.13	15.60	33.17	150.63	28.70
T_3	211.90	18.53	12.51	17.27	35.13	171.23	31.10
T_4	163.30	14.20	9.40	14.80	31.40	129.17	26.17
T_5	172.50	14.85	10.35	15.07	32.03	133.27	28.17
T_6	186.37	16.13	10.80	15.53	32.87	144.20	29.42
T_7	166.90	14.29	10.21	15.07	31.67	132.10	29.64
S.Em ±	7.73	0.61	0.31	0.24	0.70	6.58	1.09
CD (P=0.05)	23.81	1.88	0.95	0.73	2.16	20.28	NS
CV (%)	7.32	6.68	4.96	2.64	3.73	8.00	6.54

T_1: 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage, **T_2:** 100 % RDF + WSF spray at0.5 % concentration at tasseling stage, **T_3:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_4:** 75 % RDF + WSF at 0.5 % concentration at 6 leaf growth stage, **T_5:** 75 % RDF + WSF spray at 0.5 % concentration at tasseling stage, **T_6:** 75 % RDF + WSF spay at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_7:** RDF (150: 75: 40 kg NPK ha^{-1}).

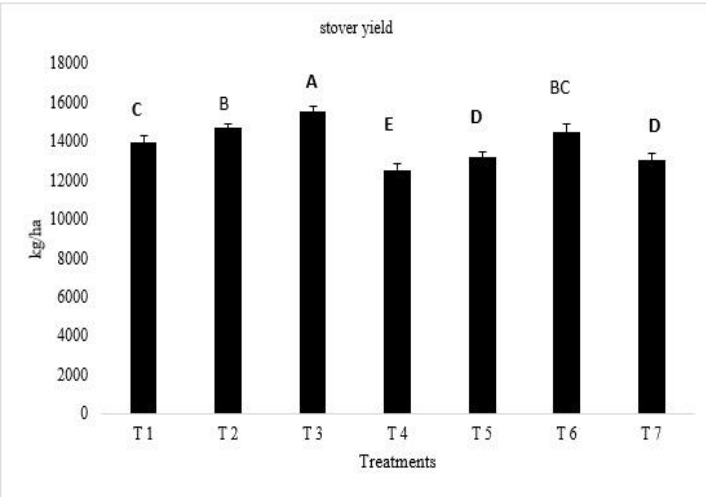
Figure 1. Kernel yield of maize as influenced by foliar application of water soluble NPK fertilizers



T_1: 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage, **T_2:** 100 % RDF + WSF spray at0.5 % concentration at tasseling stage, **T_3:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T_4:** 75 % RDF + WSF at 0.5 % concentration at 6 leaf growth stage, **T_5:** 75 % RDF + WSF spray at 0.5 % concentration at tasseling stage, **T_6:** 75 %

RDF + WSF spay at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T$_7$:** RDF(150:75:40kgNPKha

Figure 2. Stover yield of maize as influenced by foliar application of water soluble NPK fertilizers



T$_1$: 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage, **T$_2$:** 100 % RDF + WSF spray at0.5 % concentration at tasseling stage, **T$_3$:** 100 % RDF + WSF spray at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T$_4$:** 75 % RDF + WSF at 0.5 % concentration at 6 leaf growth stage, **T$_5$:** 75 % RDF + WSF spray at 0.5 % concentration at tasseling stage, **T$_6$:** 75 % RDF + WSF spay at 0.5 % concentration at 6 leaf growth stage and tasseling stages, **T$_7$:** RDF (150:75:40kgNPKha^{-1}).

Conclusion

Application of 100% RDF + WSF spray at 0.5% (19: 19: 19 NPK) at 6 leaf growth stage and tasseling stage recorded significantly higher growth yield, total dry matter accumulation (Table 1, 2, 3 and 4), maize kernel yield and stover yield (Figure 1 and 2). Higher net returns (Rs. 72500 ha^{-1}) and B: C ratio (2.8) were also recorded with 100 % RDF followed by 0.5 % foliar spray of water-soluble fertilizers at 6 leaf growth stage and tasseling stage compare to other treatments which could be adopted in maize cultivation for higher kernel yield and economic returns. Further research is suggested to be carried out to foliar application of micronutrients determine their impact of on yield of maize.

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