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Research article

PRODUCTIVITY, NUTRIENT UPTAKE AND ECONOMICS OF *RABI* SUNFLOWER (*HELIANTHUS ANNUUS*. L) AS INFLUENCED BY TILLAGE PRACTICES AND NITROGEN MANAGEMENT

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ABSTRACT: A field experiment was conducted during *Rabi* 2011 at Research farm, RARS, Bijapur on a deep black soil under rainfed condition with an objective to study the effect of different tillage practices imposed during *kharif* and nitrogen management on productivity, nutrient uptake and economics of *rabi* sunflower. Tillage practices had no significant effect on seed yield and stalk yield of sunflower crop. Seed yield (1187.5 kg ha $^{-1}$) and stalk yield (2483.8 kg ha $^{-1}$) of sunflower were significantly higher with 100% Recommended dose through fertilizer (N_3) over N_4- Farmers' practice (24:30:0 N:P_2O_5:K_2O kg ha $^{-1}$) but was on par with rest of the treatments. Significantly higher N uptake was seen with conventional tillage over minimum tillage but was on par with reduced tillage. Neither P nor K uptake was significantly influenced due to tillage practices in sunflower during *rabi* season. Sunflower fertilized with 100% recommended dose of fertilizer (N_3) recorded significantly higher N, P and K uptake at harvest. Maximum gross returns (38061Rs ha $^{-1}$) and net returns (28729 Rs ha $^{-1}$) was realized for the treatment combination T_3N_3 (Minimum tillage with 100% recommended dose of fertilizer). Reducing the tillage intensity does not significantly influence economics and substituting 50% nitrogen through organic sources produces comparable yields that of inorganic source of nitrogen application.
Key words: productivity, nutrient uptake, economics, *rabi* sunflower, tillage, sunnhemp incorporation.

INTRODUCTION

Oilseeds play an important role in agricultural economy of India. Oilseeds are important next only to food grains in terms of area, production and value [2]. The production of oilseeds in India is below the target levels. The shortage of edible oils has become a problem in India with increasing demographic pressure. During 2010-11, the country imported about 9.2 m t of vegetable oils costing around Rs. 38,000 crores [2]. Sunflower can play a key role in meeting out the shortage of edible oils in the country. Among oilseed crops, sunflower has gained much popularity and the area under its cultivation is gradually increasing because of its short duration, photo-insensitivity, wider adaptability to different agro-climatic regions and soil types. In addition to higher seed multiplication ratio, it has good quality oil containing more of unsaturated fatty acids and anti-cholesterol property, tolerance to drought and production of more oil per unit area and unit time than any other oilseed crops which makes it a potential oilseed crop especially under rainfed conditions. The major factors attributing to less productivity of sunflower in India are that the crop is grown on marginal lands with low organic matter and poor fertility under rainfed conditions and inadequate application of major nutrients like nitrogen. As soils under rainfed condition are low in organic carbon status, there is a need to enhance application of organic matter for improving productivity. In recent years, there has been renewed focus on resource conservation technologies, *viz*,. reduced tillage, maintenance of vegetative cover and crop rotation, which in totality are called conservation agricultural practices [8]. Conservation tillage will reduce the cost of cultivation, controls erosion and compaction, improve land productivity by way of improved soil physical properties, reduced soil loss and enhanced soil organic carbon and greater retention of moisture [6]. Incorporation of organic matter (green manure) influences the soil fertility status by nitrogen fixation and reduces erosion, increases water holding capacity and controls weed growth.

Traditional sources of organic manure like FYM are becoming scarce due to several limitations which are to be substituted with organic manures which alone cannot fulfill the heavy nutrient demand of an intensive cropping system because of its low nutrient content and slow nutrient release vis-à-vis fertilizers. In some of the deep black soils, cropping is restricted to *rabi* due to the difficulty in working during the *kharif* season. However, farmers do take up repeated harrowing for conserving moisture whenever the moisture conditions permit. The number of ploughings under such conditions often exceeds 6-7, when we consider the summer ploughing and other tillage measures. In recent years, it has been proved that repeated tillage measures are not beneficial. Black soils provide scope for introducing a green manure crop like Sunnhemp, which can contribute nitrogen for succeeding crop besides contributing positively for soil organic carbon improvement. The information on different tillage systems in conjunction with integrated use of nitrogen during *Rabi* season on sunflower is inadequate. Keeping these points in view, the present investigation was conducted to study the effect of different tillage practices and nitrogen management on productivity, nutrient uptake and economics of *rabi* sunflower.

MATERIALS AND METHODS

The experiment was conducted at VIII block of the Regional Agricultural Research Station, Bijapur situated in Northern Dry Zone of Karnataka state at 16º49'N latitude, 75 º 43' E longitudes and at an altitude of 593.8 m above mean sea level. The soil of the experimental field field was clayey in texture, strongly alkaline in reaction (pH 8.6), Electrical conductivity (1:2.5 soil : water)(0.2 ds m^{-1}), low in organic carbon (0.37%), nitrogen (163 kg ha^{-1}) and phosphorus (22 kg ha^{-1}) and medium in available potassium (330 kg ha^{-1}). The total rainfall received during the crop season was 120.4 mm with 16 rainy days. The experiment was laid out in a split plot design with three replications. The treatments consisted of 3 main plots (Tillage practices) T_1 – Conventional tillage-one summer ploughing and 2 harrowings before sowing, T_2– Reduced tillage -harrowing twice before sowing, T_3 – Minimum tillage–harrowing once before sowing; and 5 sub plots (nitrogen management) N_1 – In- situ sunnhemp green manure incorporation @ 5 t biomass ha^{-1}, N_2 – In- situ sunn hemp incorporation @ 2.5 t biomass ha^{-1} + 50% recommended dose of nitrogen through urea, N_3 –100% recommended dose through fertilizer (35:50:35; N: P_2O_5 : K_2O kg ha^{-1}) N_4–Farmers' practice (24:30:0 ; N:P_2O_5 :K_2O kg ha^{-1}) N_5 – Farmers' practice + In situ sunnhemp green manure incorporation @ 2.5 t ha^{-1}. Main plot treatments were imposed in *Kharif* season and Sunflower was sown in *Rabi* season. Sunnhemp was grown and incorporated after imposing main treatments. Local variety of sunnhemp was broadcasted in the green manure plots at the seed rate of 10 kg ha^{-1} and 5 kg ha^{-1} as per the treatments. Sunnhemp was incorporated into the soil 47 days after sowing. KBSH-1 hybrid of sunflower was used for sowing with a recommended spacing of 60 x 20 cm at a depth of 3 to 4 cm. The crop was grown purely as a rainfed crop. A uniform dose of 50 kg P_2O_5 and 35 kg K_2O ha^{-1} was band placed through single super phosphate, muriate of potash respectively in N_1, N_2 and N_3 and in case of N_4 and N_5, 24 kg N and 30 kg P_2O_5 was applied and nitrogen was applied through urea as per the treatments as basal dose. The fertilizers were band placed from the crop row.

RESULTS AND DISCUSSION

Perusal of the data indicated that tillage practices could not influence both the seed yield and stalk yield of sunflower significantly during the *rabi* season. This finding corroborates the results of [5]. The seed yield of sunflower was significantly influenced due to nitrogen management treatments. Among different nitrogen management treatments, 100% RDF through fertilizer (N_3) produced significantly higher seed yield of 1187 kg ha^{-1} than that of farmer's practice (24:30:0 N:P_2O_5:K_2O kg ha^{-1}-N_4) which recorded lowest yield of 872 kg ha^{-1}. However, seed yield of sunflower with 100% RDF through fertilizer (N_3) was on par with rest of the treatments *viz*., N_2, N_1 and N_5. Same trend was reflected as far stalk yield was concerned where N_1 besides N_4, differed significantly from rest of the treatments (N_2, N_3 and N_5). Seed yield with 100% RDF through fertilizer (N_3) was 2.0, 15.5, 16.0 and 36.0 per cent more compared to In-situ sunnhemp green manure incorporation @ 2.5 t ha^{-1} + 50% RDN through urea (N_2), In -situ sunnhemp green manure incorporation @ 5 t biomass ha^{-1} (N_1), farmer's practice + In-situ sunnhemp green manure incorporation @ 2.5 t ha^{-1}(N_5) and farmer's practice (24:30:0 N:P_2O_5:K_2O kg ha^{-1} –(N_4) respectively. Increased seed yield of sunflower was due to increase in yield attributes like number of seeds per head, filled seeds per head, seed weight per head and test weight. Increased nutrient availability due to adequacy of instant NO_3^- ions from inorganic source during seedling and grand vegetative stage might have increased dry matter production and its better partitioning resulted in improvement of yield contributing characters, culminating in higher seed yield and stalk yield which was clearly observed in case of N_3.

Increase in seed yield was also due to addition of organic matter (green manure) which upon decomposition (mineralisation), released nutrients in available form for crop absorption slowly during subsequent stages of growth and development in sunflower in N_2 treatment which performed on par with N_3 as far growth contributing and yield attributing characters are concerned. Similar results were reported by [4] and [3]. The interaction effect due to tillage practices and nutrient management on seed and stalk yield of sunflower was not significant. N and P content in sunflower was significantly influenced by tillage practices and nitrogen management, while no significant effect was seen on K content. Significantly higher N and P content was seen with conventional tillage over minimum tillage, but both of these were on par with reduced tillage indicating irrespective of method and number of tillage, sunflower absorbed nutrients efficiently to maintain optimum N and P content for good growth and development. Among nitrogen management treatments, significantly higher N content of sunflower was recorded with 100% RDF through fertilizer (N_3) than rest of the treatments which might be due to ready availability of nitrogen through inorganic source. Significantly higher P content was seen with 100% RDF through fertilizer (N_3) and In- situ Sunnhemp green manure incorporation @ 2.5 t ha $^{-1}$(N_5) and both of these differed significantly from rest of the treatments (N_1, N_2 and N_4). The interaction effect due to tillage practices and nitrogen management on NPK content was not significant.

N uptake by sunflower at harvest was significantly influenced by tillage practices and nitrogen management. Significantly higher N uptake was seen with conventional tillage over minimum tillage but was on par with reduced tillage. More N content and corresponding dry matter contributed for higher nitrogen uptake in T_1 (Conventional tillage) and T_2(Reduced tillage). Similar results were reported by [7]. Neither P nor K uptake was significantly influenced due to tillage practices in sunflower during *rabi* season. Significantly higher N uptake in sunflower was recorded with 100% RDF through fertilizer (N_3) than rest of the treatments. Ready availability of nitrogen though inorganic source in N_3 was the reason for higher N uptake.

Table 1. Grain yield, NPK content and NPK uptake of sunflower as influenced by tillage practices and nitrogen management

Treatments	Grain yield (kg ha $^{-1}$)	Stalk yield (kg ha $^{-1}$)	NPK content (%)			NPK uptake(kg ha $^{-1}$)		
			N	P	K	N	P	K
Main- plot treatments (Tillage Practices)								
T_1- Conventional Tillage- 1 summer ploughing and 2 harrowings	1017.3	2265.3	1.22	0.34	4.03	57.35	15.81	188.34
T2 - Reduced Tillage- 2 harrowings	999.9	2206.1	1.18	0.32	3.84	54.74	13.61	179.85
T3 - Minimum Tillage- 1 harrowing	1148.6	1940.9	1.05	0.29	3.67	46.53	13.90	161.96
SEd ±	48.4	219.1	0.04	0.01	0.81	2.51	0.70	35.43
CD (P=0.05)	NS	NS	0.12	0.03	NS	6.93	NS	NS
Sub- plot treatments (Nitrogen management)								
N_1-Sunnhemp incorporation @ 5 t ha $^{-1}$	1028.2	1993.6	1.08	0.29	3.78	47.54	12.85	166.46
N_2- Sunnhemp incorporation @ 2.5 t ha $^{-1}$+ 50% N through urea	1167.8	2182.2	1.08	0.29	4.16	51.58	13.59	197.25
N_3-100% RDF(35:50:35; N: P_2O_5 :K_2O)	1187.5	2483.8	1.36	0.35	4.28	68.28	17.41	212.79
N_4- Farmers' practice (24:30:0; N:P_2O_5 :K_2O)	872.9	1674.9	1.10	0.30	3.00	44.23	12.21	121.65
N5- N4+ Sunnhemp incorporation @ 2.5 t ha -1	1020.0	2352.8	1.14	0.35	4.01	52.74	16.15	185.69
SEd ±	99.3	200.3	0.06	0.01	0.61	3.50	0.73	26.67
CD (P=0.05)	205.0	413.4	0.13	0.03	NS	7.23	1.52	55.06
Interaction (Tillage X Nitrogen)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Economics of sunflower as influenced by tillage practices and nitrogen management

Treatments	Gross returns (Rs ha $^{-1}$)	Net returns (Rs ha $^{-1}$)	Cost of cultivation (Rs ha $^{-1}$)	B:C ratio
T_1N_1	28295	15976	12319	1.30
T_1N_2	29201	16473	12728	1.29
T_1N_3	30813	18331	12482	1.47
T_1N_4	28899	16990	11909	1.43
T_1N_5	30309	18056	12253	1.47
T_2N_1	26726	16557	10169	1.63
T_2N_2	34898	24320	10578	2.30
T_2N_3	29604	19272	10332	1.87
T_2N_4	24489	14730	9759	1.51
T_2N_5	26918	16815	10103	1.66
T_3N_1	34438	25269	9169	2.76
T_3N_2	36142	26564	9578	2.77
T_3N_3	38061	28729	9332	**3.08**
T_3N_4	22556	13797	8759	1.58
T_3N_5	31517	22414	9103	2.46

Sale price of seed- 29 Rs kg $^{-1}$

Main- plot treatments (Tillage Practices)
T_1- Conventional Tillage (1 summer ploughing and 2 harrowings before sowing)
T_2-Reduced Tillage (Harrowing twice before sowing)
T_3-Minimum Tillage (Harrowing once before sowing)

Sub- plot treatments (Nitrogen management)
N_1- In -situ Sunnhemp green manure incorporation @ 5 t biomass ha $^{-1}$
N2- In- situ Sunnhemp green manure incorporation @ 2.5 t ha $^{-1}$ + 50% RDN through urea
N3-100% RDF through fertilizer(35:50:35 N: P_2O_5: K_2O) kg ha $^{-1}$
N_4- Farmer's practice (24:30:0 N:P_2O_5:K_2O kg ha $^{-1}$)
N_5- Farmer's practice + In-situ Sunnhemp green manure incorporation @ 2.5 t ha $^{-1}$

Significantly higher phosphorus uptake of sunflower was recorded with 100% RDF through fertilizer (N_3) than rest of the treatments except farmer's practice +In- situ Sunnhemp green manure incorporation @ 2.5 t ha $^{-1}$(N_5), due to more P content and dry matter production. Significantly higher potassium uptake of sunflower was recorded with 100% RDF through fertilizer (N_3) than farmer's practice (N_4) but was on par with rest of the treatments (N_1, N_2 and N_5). This might be due to more availability of potassium with inorganic and organic source in N_1, N_2 and N_3 whereas potassium application was completely ignored in treatment N_4. The interaction effect due to tillage practices and nitrogen management on NPK uptake of sunflower was not significant.

Maximum gross returns (38061Rs ha $^{-1}$) and net returns (28729 Rs ha $^{-1}$) were realized for the treatment combination T_3N_3 (Minimum tillage with 100% recommended dose of fertilizer) followed by T_3N_2(35142 Rs ha $^{-1}$). The benefit cost ratio of T_3N_3 was highest (3.08) followed by T_3N_2 (2.77). Application of recommended dose of fertilizer contributed to higher seed yield and mimimum tillage had less cost of cultivation which in turn increased the gross returns, net returns and Benefit-cost ratio. Similar results were reported by [7] and [1].

CONCLUSION

Minimum tillage (T_3) with one harrowing was found to be the optimum tillage practice for good growth and development and for getting higher productivity, nutrient uptake and economics of sunflower on clay soil under dry conditions of Bijapur. Application of recommended dose of fertilizer contributed to higher seed yield and mimimum tillage had less cost of cultivation which in turn increased the gross returns, net returns and Benefit-cost ratio.

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