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Residual effect of nitrogen levels and weed control methods on growth, yield and economics of wheat grown after rice

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Abstract

A field experiment was laid out in split plot design on residual effect of treatments comprising three nitrogen levels viz. N₇₅ (N₁), N₁₀₀ (N₂) and N₁₂₅ (N₃) in main-plot treatments and seven weed control treatments viz. (W₁-butachlor + 1 Hand Weeding, W₂-butachlor + 2 Mechanical Weeding, W₃-butachlor + 2,4-D, W₄-bispribac sodium, W₅-butachlor + bispribac sodium, W₆-HW-2, W₇- control) as sub-plot treatments conducted during 2015-16 and 2016-17 at the Rajaula Agriculture Farm, MGCGVV, Satna (M.P.) to study the residual effect of N-levels and weed control methods on growth, yield and economics of wheat grown after rice. In case of succeeding wheat, the residual 125 kg N/ha performed the best with respect to growth, yield-attributes with the result 31.11 q/ha grain yield and Rs.33509/ha income. While, under sub plot treatments, Hand weeding two times were recorded significant grain yield (28.66 q/ha) and straw yield (38.17 q/ha) at (P <0.05) over control. However it was found non-significant different and also noticed higher over rest treatments. In this succession, Butachlor + 2, 4-D (0.80 kg/ha) was higher but in second position and similar trend was observed in successive way with rest of treatments.

Keywords: Economics, Nitrogen levels, Residual effect, Weed Control Methods, Yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second major cereal crop of India next to rice. In Madhya Pradesh, with its large area, enjoys diverse climatic and soil conditions suitable for a broad range of agricultural products. Agriculture sector in Madhya Pradesh forms the backbone of its economy. It contributes almost one-fourth of the Gross State Domestic Product (GSDP) and is the main source of employment for over 65 percent of the population and constitutes about 60- 75 percent of the rural income.

Conventionally full tillage (3-4 passes) is done for sowing of wheat. The nutrients applied to rice crop are not fully utilized, which leads to their residual effect on the succeeding wheat crop. Nitrogen is a major nutrient required in the larger amount in cereal crop. Huge losses of nitrogen due to various ways including by weeds is very common. However, weed infestation is a major

constraint to get optimum wheat yield under residual effect of nitrogen level. To resolve this problem, herbicide is a wise option to manage weeds (Gianessi, 2013) as it is a low cost, less labour and time demanding (Parvez, 2013); and target specific method of weed control (Simmons, 2006). Herbicides are typically used for controlling weeds by applying in soil or foliage. It is expected to control weeds by chemical within the season of application, while it is unpredicted the persistency of herbicides in soil and their residual effect on the various crop growth. Although the use of herbicides creates public concern and receives much criticisms from naturalists and environments, but still herbicides are widely used for weed control in developed countries as well as in many developing countries like India. The area under herbicidal weed control has unexpectedly increased in India within last few years and it is not only for the increasing labor crisis or not for the cheap price of

herbicides. Herbicide offers effective control on strong competing weeds and ensures competition free environment for better crop establishment. Therefore, herbicides has a role to greatly improve crop yield especially in wheat through effective weed control under residual effect (Zahan, 2016) and that's why, adaptation level of herbicidal weed control is high in wheat at farmers' field (Gianessi, 2014). In India where overall cropping intensity is 1.91, there is a high risk of using herbicides in rotational crops having high persistency in soil and continuous application of same herbicide repeatedly in the same field year after year increases the possibility of herbicide persistency in soil. Preferably, herbicide should remain chemically active long enough to provide satisfactory weed control up to critical period of weed competition during crop growing season and then it should degrade into inoffensive products.

Several studies have shown herbicides are not generally susceptible to leaching when applied to the soil. Weeds can be controlled by herbicides, but it can be affect soil bio-chemical properties. Kiran *et al.* (2015) observed that root length, shoot length, seedling vigour and seed yield of succeeding mungbean were not affected when bispyribac was applied in the previous transplanted rice. Uncontrolled weeds are reported to cause upto 66% reduction in wheat grain yield (Kumar *et al.*, 2011) or even more depending upon the weed density, type of weed flora and duration of infestation. It was important to investigate the changes in morphological and reproductive parameters under residual effect of different N-levels and weed control treatments. This was required in relation to the productivity and net income from wheat after rice under the existing agro-climatic conditions. Therefore, the present research was taken up.

MATERIALS AND METHODS

The field experiment was carried out during rainy seasons of 2015 and 2016 at the Rajaula Agriculture Farm, MGCGVV, Satna (M.P.). The soil of the experimental site was sandy-loam in texture and neutral in soil reaction (pH 7.46). The soil was low in nitrogen, medium in phosphorus and high in potash. The total rainfall received during the crop season was 584.3 mm distributed in 31 rainy days. The experiment was laid out in split plot design on residual effect of treatments comprising three nitrogen levels viz. N₇₅ (N₁), N₁₀₀ (N₂) and N₁₂₅ (N₃) in main-plot treatments and seven weed control treatments viz. (W₁-butachlor + 1 Hand Weeding, W₂-butachlor + 2 times Mechanical Weeding, W₃-butachlor + 2,4-D, W₄-bispyribac sodium, W₅-butachlor + bispyribac sodium, W₆-Hand Weeding in 2 times, W₇- control) as sub-plot treatments. Before transplanting rice crop, an uniform dose of 60 kg P₂O₅ + 40 kg K₂O/ha was applied in all the plots through SSP and MOP, re-

spectively. Nitrogen was applied through urea in 3 split doses i.e. 50% at basal, 25% at tillering and 25% at panicle-initiation stages. The crop was harvested on 22 November 2015 and on 12 November 2016. The succeeding wheat crop (GW-322) was sown @ 100 kg/ha on the same plots in which rice was harvested. It was shown on 20 November in 2015 and on 25 November in 2016 and harvested on 20 March in 2016 and on 27 March in 2017.

Statistical analysis : To test the significance, the experimental data collected on various aspects of the investigation on maize and soil were statistically analyzed with the procedure described by Cochran & Cox (1967) and adopted by Cheema and Singh (1991) in statistical package CPCS-1. All the comparisons were made at 5% level of significance.

Sampling techniques

Plant population: The plant population per metre row length was recorded at 20 DAS from five row selected randomly and mean number of plants per metre row length was worked out and later converted into plants per square metre by multiplying with number of row in one metre area. For plant growth and yield attributes five randomly selected plants from each plot were tagged and their yield contributing characters were measured. Finally, mean was computed.

Seed yield: The seed yield per net plot was recorded after winnowing the produce. Finally, seed yield of each plot was converted into seed yield per hectare by multiplying with appropriate conversion factor.

Stover yield: The straw yield per plot was determined by subtracting seed yield (economical yield) of each plot from biological yield (bundle weight) of the same plot. This was later on converted in to straw yield per hectare by multiplying with the same conversion factor which was used in case of seed yield per hectare.

The observations on crop growth, yield attributes and yield were recorded in all the treatments at the time of harvest. Harvest index was calculated as the ratio of grain yield to the biological yield. It was calculated as per the formula proposed by Nichiporovich (1967).

$$\text{Harvest Index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100 \quad \text{Eq. 1}$$

RESULTS AND DISCUSSION

Growth parameters: The data in Table 1 indicated that the highest level of residual nitrogen (N₁₂₅) resulted in significantly highest plant height, total and effective tillers/m length and dry weight/plant of wheat as compared to the lower levels of nitrogen. At the highest nitrogen level, the plant height

Table 1. Growth parameters and yield-attributes of wheat as influenced by residual effect of different treatments (Pooled analysis of 2 years data).

Treatments	Plant height (cm) at harvest	Total tillers/m	Effective tillers/m length	Dry matter/ (g) 60 DAS	Number of spikes/plant	Length of spike (cm)	Spikelets/ spike	Seeds per spike
Nitrogen levels(kg/ha)								
N ₇₅	92.3	91.2	83.1	5.64	2.42	9.19	16.07	34.06
N ₁₀₀	94.8	101.0	93.8	6.36	2.70	9.73	16.66	35.81
N ₁₂₅	99.6	109.5	103.4	6.97	2.96	10.82	17.88	38.79
CD (P=0.05)	3.16	3.22	3.21	0.33	0.17	0.29	0.63	1061
Weed control methods								
W ₁ -Buta. (0.75 kg/ha) + 1 HW	96.2	100.9	95.1	6.41	2.78	9.89	17.24	36.33
W ₂ -Buta. + 2 MW	97.2	101.9	94.0	6.61	2.65	9.67	17.09	37.22
W ₃ -Buta. + 2, 4-D (0.80 kg/ha)	96.6	101.4	93.2	6.43	2.66	10.25	17.31	36.21
W ₄ -Bispyribac(20 g/ha)	95.4	100.5	93.4	6.48	2.73	10.09	16.86	36.64
W ₅ -Butachlor + Bispyribac	97.0	100.7	95.0	6.49	2.75	10.17	16.81	37.74
W ₆ -Hand weeding (2)	96.4	101.7	93.7	6.55	2.74	10.42	17.58	37.78
W ₇ -Unweeded control	90.4	97.0	89.7	5.33	2.54	8.90	15.22	31.63
CD (P=0.05)	3.68	NS	3.58	0.34	0.11	0.33	0.72	1.80
Interactions	NS	NS	NS	NS	Sig.	Sig.	NS	NS

Remarks: 1 HW = one Hand weeding, 2 MW= two mechanical weeding, Buta.= Butachlor

Table 2. Yield-attributes, yield and economics of wheat (GW 322) under residual effect of different treatments (Pooled analysis of 2 years data).

Treatments	Seed spike (g)	Seed weight/ plant (g)	Test weight/ 1000-grains (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Net income (Rs./ha)	B:C ratio
Nitrogen levels(kg/ha)								
N ₇₅	1.85	22.77	42.52	23.00	35.33	39.41	20334	2.02
N ₁₀₀	1.91	25.19	43.86	24.43	35.29	41.01	22845	2.14
N ₁₂₅	2.14	27.01	46.05	31.11	37.31	45.48	33509	2.68
CD (P=0.05)	0.07	1.62	NS	1.73	1.62	3.24	--	--
Weed control methods								
W ₁ -Buta. (0.75 kg/ha) + 1 HW	1.96	25.07	43.71	26.66	36.20	42.39	26267	2.31
W ₂ -Buta. + 2 MW	1.91	25.28	44.80	26.32	36.16	42.00	25726	2.29
W ₃ -Buta. + 2, 4-D (0.80 kg/ha)	1.97	24.87	44.41	27.01	35.79	42.82	26815	2.34
W ₄ -Bispyribac(20 g/ha)	1.99	25.43	44.20	25.69	36.14	41.27	24709	2.24
W ₅ -Butachlor + Bispyribac	2.05	25.94	45.45	26.99	36.49	42.34	26831	2.35
W ₆ -Hand weeding (2)	2.06	26.69	46.08	28.66	38.17	42.62	29691	2.49
W ₇ -Unweeded control	1.82	21.67	40.36	22.26	32.89	40.34	18899	1.95
CD (P=0.05)	0.07	1.80	NS	2.28	1.80	NS	----	----
Interactions	Sig.	NS	NS	Sig.	Sig.	NS	----	----

Remarks: 1 HW = one Hand weeding, 2 MW= two mechanical weeding, Buta.= Butachlor

was significantly ($P < 0.05$), maximum (99.6 cm), total and effective tillers (109.5 and 109.4/m length, respectively) as well as dry weight (6.97 g/plant) were noticed during experimentation. In fact, the trend and limit of vegetative growth before the start of reproductive phase is mainly governed by the genetically behaviour inherited in the high-yielding wheat plant type as well as by the crop management practices of the region.

The boosted vegetative growth (plant height and number of tillers/m length) due to increased nitrogen levels may be because of the fact that the applied nutrient promoted plant growth by ensuring higher number of greener leaves with increased photosynthesis. Profuse root development particularly due to increased availability of residual nitrogen insured more absorption of minerals, nutrients and soil moisture from the deeper soil layers. These favourable soil conditions brought about efficient utilization of plant nutrients accompanied by activating plant enzymes. The remarkable increase in plant height and formation of higher number of tillers/m length due to higher doses of residual nitrogen associated activities may be as a result of acceleration of cell elongation and cell division. Moreover, these growth parameters were predominantly augmented by nitrogen levels which might be due to the fact that nitrogen being major nutrient is essential for building up of protoplasm and protein which induce cell division and enlargement with initial meristematic activity. Improvement in P uptake by wheat crop with N levels may be due to the increase in grain and straw yield and P content is corroborated by Jaga *et al.*, (2017) and Grain and straw yields of wheat were 24.2 and 23.4 % higher with 7.5 t FYM/ha over control. The content and yield of protein increased significantly with the addition of N upto 120 kg N/ha reported at Bichpuri, Agra, Uttar Pradesh by (Singh *et al.*, 2017).

Amongst the residual effect of weed control treatments, W_1 to W_6 resulted in almost equally significantly higher plant height, effective tillers and dry weight/plant in comparison to W_7 (control). Among them, W_2 - Buta. + 2 MW was produced maximum plant height (97.2 cm), total tiller (101.9), dry weight (6.61 g) from series of treatments but noticed lower in effective tillers than W_1 -Buta. (0.75 kg/ha) + 1 HW (95.1) during experimentation. This was due to equal effect of combined or separately applied herbicides as well as herbicides with mechanical/hand weeding. These treatments equally controlled existing weed-flora thereby avoided the wheat plants against weed competition for space, light soil-moisture and nutrients. Consequently, increased photosynthates in W_1 to W_6 treatments translocated from vegetative stage towards the reproductive organs of the plants. The beneficial influence of such treatments towards yield-attributes of wheat has also been reported by Ma-

lik *et al.* (2004) reported that Clodinafop at 60 g/ha applied after first irrigation yielded significantly higher grain yield over weedy check. Yadav *et al.* (2004),

Yield-attributes: The maximum N-level up to N_{125} recorded significantly highest number of spikes (2.96/plant), spike length 10.82 cm, spikelet 17.88/spike, 38.79 seeds/spike, seed weight 2.14 g/spike, 1000-seed weight 46.05 g and seed weight (27.01/plant) over the preceding N-levels. The probable reason may be ascribed as it resulted in greater accumulation of carbohydrates, protein and their translocation to the reproductive organs which, in turn, increased the higher number of spikes and grain weight/plant as well as other yield-components. The increase in the yield-attributes due to nitrogen application to wheat has also been reported by many workers on wheat crops (Singh *et al.*, 2013; Chauhan *et al.*, 2014; Jat *et al.*, 2014; Kumar *et al.*, 2015 and Vinod kumar *et al.*, 2017).

The yield-attributes of wheat (spikes/plant, length of spike, spikelets/spike, seeds/spike, seed weight/plant and 1000-seed weight were found equally significantly ($P < 0.05$) higher in case of W_1 to W_6 weed control methods over control (W_7). This was due to the fact that each of the applied residual weed control treatments controlled the weeds upto equally maximum extent, thereby reducing the crop-weed competition for space, light, soil-moisture and nutrients. Consequently the increased photosynthates in W_1 to W_6 treatments translocated towards the reproductive organs of the wheat plants. The present findings have been supported by several researchers on the same crops (Yadav *et al.*, 2004; Bhardwaj *et al.*, 2004; and Jain, 2005).

Productivity of wheat: The application of highest N-level (N_{125}) to rice (PS-5) significantly higher grain and straw yield of succeeding wheat as compared preceding N-level. The overall grain and straw yield of wheat cv. GW 322 was found higher by 8.11 and 2.00 q/ha due to N_{125} over lowest N_{75} (Summary Table 6.4). The trend of increases in grain and like straw yield obtained due to these treatments was exactly in accordance with the similar increases recorded in the yield-attributing characters (spikes/plant, seeds/spike, spike length, spikelets/spike, seed weight/spike, test weight and grain yield/plant, and the increased vegetative growth. The present findings are in accordance with those of many researchers on same crops (Singh *et al.*, 2013; Chauhan *et al.*, 2014; Jat *et al.*, 2014; Kumar *et al.*, 2015; Jaga *et al.*, 2017; Singh *et al.*, 2017 and Vinod Kumar *et al.*, 2017).

The residual effect of different weed control treatments on the productivity of succeeding wheat was found to be influenced up to significant extent. Hand weeding twice (W_6) resulted in signifi-

cantly higher grain and straw yield (28.66 and 38.17 q/ha, respectively). This was closely followed by W₅ and then W₃. The higher productivity in these treatments might be owing to increased yield-attributing parameters. The dual herbicides in these treatments (butachlor + 2,4-D and butachlor + bispyribac sodium) played unique and combined role in the control of weed-flora, which ultimately reduced the crop-weed competition for space, light, soil moisture and nutrients and consequently higher production of photosynthates and their translocation towards the reproductive organs responsible for the enhanced productivity. The significant role of dual herbicides in what productivity has been reported on wheat crops by Yadav *et al.* (2004), Jain (2005) and Kumar *et al.* (2005).

Economical gain from wheat: The highest level of nitrogen (N₁₂₅) applied to rice brought about the highest net-return from succeeding wheat up to Rs.33509/ha as revealed from Table 2. It was higher by Rs.13175/ha over the lowest N-level (N₇₅). This was eventual as the higher net return is directly correlated with the higher grain and straw production per hectare. In case of weed control treatments, W₆ (HW twice) recorded maximum net income upto Rs. 29691/ha. It was higher by Rs.10792/ha over control (W₇). All the weed control treatments (W₁ to W₆) proved almost equally effective in giving the net income ranging from Rs. 24709/ha in case of W₄ to Rs. 26831/ha in case of W₅. This is in accordance with the seed yield/ha from these treatments. Vinod Kumar *et al.* (2017) also found that increasing levels of nitrogen up to 90 kg/ha increased the net income and B:C ratio from wheat (PBW-502). The application of respective noted treatment which given higher yield has significant result at level of (P <0.05) over control in wheat crops. The different workers were noted the same result at different level of nitrogen and suggested that hand weeding may be done on availability of laborers on easily otherwise integrated weed management is best and will maintain sustainability.

Conclusion

On the basis of the experimental findings, it was concluded that application of 125 kg of N and two hand weeding has obtained maximum value of grain, straw as well as B: C ratio on residual effect after rice crop. However, the application of combined herbicide i.e. Butachlor + Bispyribac can be used satisfactorily to some extent than manual weeding in the regions where there is scarcity of laborers.

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