Annals of Plant and Soil Research 19(1): 75 – 79 (2017)

Effect of weed management and nitrogen on productivity and economics of wheat

R.S. CHAUHAN*, ARVIND KUMAR SINGH[1] GOPI CHAND SINGH AND S.K. SINGH

Krishi Vigyan Kendra, Raja Balwant Singh College, Bichpuri, Agra (U.P.) 283 105

Received: June 2016; Revised accepted: December, 2016

ABSTRACT

Field experiments were carried out to investigate the efficiency of nitrogen levels (60, 90 and 120 kg ha^{-1}) and different post-emergence herbicides (Isoproturon, Metsulfuron- methyl, Clidinafop Propargyl, Carfentrazone-ethyl, Isoproturon + Metsulfuron- methyl, Clidinafop propargyl + Metsulfuron-methyl, Isoproturon + Carfentrazone-ethyl, Clidinafop propargyl + Carfentrazone-ethyl) and weedy check at farmers' field Nagla Heera Singh village in Agra district (UP) during rabi seasons of 2011-12 and 2012-13 on weed dynamics and productivity of wheat [Triticum aestivum (L.) emend. Fiori & Paol.]. Results revealed that post-emergence application of tank mix herbicide (Clidinafop propargyl 15% WP + Carfentrazone-ethyl 40% DF) at 32 DAS significantly reduced density (4.0 m^{-2}) and dry weight (36.5 g m^{-2}) of weeds over weedy check. This treatment resulted highest plant height (103.7 cm), dry matter (434.7 g), grain (48.10 q ha^{-1}) and straw yield (64.94 q ha^{-1}) with higher monetary returns (` 53782 ha$^{-1}$) and B:C ratio (3.20) followed by Isoproturon + Carfentrazone-ethyl (` 53538 ha^{-1}). Weed biomass significantly increased with the increase in N levels up to 120 kg ha^{-1}. Increasing N levels up to 120 kg ha^{-1} significantly improved the plant height (102.7 cm) dry matter (414.6 g) thereby resulted in significantly highest grain (45.45 q ha^{-1}) and straw (80.45 q ha^{-1}) yield with net profit (` 47073) and benefit cost ratio (2.99). The lower values of these parameters were recorded under 60 kg N ha^{-1}.

INTRODUCTION

Wheat is the second most important cereal among food grain crops in India covering an area of 29 million hectare with a production of 87 million tonnes and total productivity of 2.91 t ha^{-1}. Due to the introduction of high yielding varieties, heavy demand of inputs, weed infestation became a major problem in the production of wheat. Now weeds are known to be one of the major constraints in wheat production as they reduce productivity due to competition, allelopathy, by providing habitats for pathogens as well as serving as alternate host for different types of insects and fungi and increased harvest cost. Studies indicated that crop losses due to weed competition throughout the world as a whole, are greater than those resulting from combined effect of insect pests and diseases. It causes yield reduction in wheat from 10- 65%. Physical methods of weed control are laborious, tiresome and expensive due to increasing cost of labor, draft animals, implements and weeds cannot effectively be managed merely due to crop mimicry, therefore, the use chemical weed control has become necessary. However, the choice of most appropriate herbicide, proper time of application and proper dose is an important consideration for lucrative. Application of herbicides decreased dry weight of weeds significantly compared to dry weight in non-treated plots and increased yield components and grain and straw yield. Slow growth of wheat plants at early stage and application of more fertilizer as well as irrigation right from sowing encourages the rapid growth of weeds, making the cultivation of wheat more problematic and if weeds are not controlled in time, they cause substantial loss in yields of 15-40% (Jat *et al.*2003). The wheat crop is infested with heavy population of common annual narrow leaf and broad-leaf weeds like *Anagallis arvensis, Argemone Mexicana, Asphodelus tenuifolius* (Piazi), *Avena ludoviciana* (Jangli Jai), *Chenopodium album, Convolvulus arvensis*, *Fumaria parviflora*, *Phalaris minor, Rumex retroflex, Spergula arvensis* etc. (Meena and Singh 2013). Presently Isoproturon, Metsulfuron-methyl Clidinafop propargyl, and Carfentrazone-ethyl are the most widely used post-emergence herbicides for narrow-leaf and broad-leaf weeds. Among the essential plant nutrients, nitrogen plays the most important role in augmenting agricultural production and its deficiency limits the crop production (Singh 2016). In view of these facts the present study was designed to screen out compatible/suitable herbicide combination for broad spectrum weed control in wheat crop and to standardize rate of nitrogen application.

MATERIALS AND METHODS

The experiment was conducted at farmers' field at village-Nagla Heera Singh, (27°25′ N, 77°9′ E and at altitude of 163.4 meter mean sea level) of Agra district (Uttar Pradesh) during rabi seasons of 2011-13. The soil was

Keywords: Soil fertility, weed management, nitrogen, productivity, economics, wheat
**Corresponding author email: chauhanraj5985@gmail.com*
[1]Department of Botany, Ram Singh Mahavidyalaya, Nagla Sikandar, Firozabad (U.P.) 283 204

sandy loam in texture, slightly alkaline in reaction (pH 7.8), low in organic carbon (3.5g kg^{-1}), available nitrogen (157 kg ha^{-1}), phosphorus (9.8kg ha^{-1}) and potassium (110 kg ha^{-1}). The experiment was laid out in a split plot design with 27 treatment combination and 3 replications. The herbicides as main plot treatments comprised T_1 - weedy check, T_2 - Isoproturon 75%WP (1 kg ha^{-1}), T_3 - Metsulfuron- methyl 20% WG (20 g ha^{-1}), T_4 - Clidinafop propargyl 15% WP (400 g ha^{-1}), T_5 - Carfentrazone-ethyl 40% DF (50 g ha^{-1}), T_6 - Isoproturon + Metsulfuron- methyl 20% WG (1 kg + 20 g ha^{-1}), T_7 - Clidinafop propargyl 15% WP + Metsulfuron- methyl (400 g + 20 g ha^{-1}), T_8 - Isoproturon + Carfentrazone-ethyl 40% DF (1 kg + 50 g ha^{-1}), T_9 - Clidinafop propargyl 15% WP + Carfentrazone-ethyl 40% DF (400 g + 50 g ha^{-1}) and nitrogen levels in sub plots (60, 90 and 120 kg ha^{-1}). Wheat variety DBW 17 was sown at test crop using 120 kg ha^{-1} in second week of November in both the years. All the herbicides were applied as post emergent at crop tillering stage i.e. about 32 days with the help of a knapsack sprayer fitted with flat fan nozzle with a spray volume of 500 liter ha^{-1}. The recommended dose of 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} was applied uniformly as basal application. Half nitrogen was applied as basal at the time of sowing where as remaining nitrogen was top dressed in two equal slots at first and second irrigation. Weed population was counted with the help of quadrate (0.25cm X 0.25cm) thrown randomly at three places in each plot and converted in to m^{-2} area. Weed count were subjected to square root transformation . The above ground weed dry matter was also recorded from the above thrown quadrates after cutting weeds from the ground level and then oven dried at 70 ^{0}C and converted to m^{-2}. The wheat crop was harvested at physiological maturity. The growth, yield attributes and yields (grain, straw) were recorded at harvest. The economics was computed using the prices of inputs and outputs as per prevailing market rates. The data generated for both years were pooled together and statistically analyzed.

RESULTS AND DISCUSSION

Weed density and dry matter

The weed community comprised both broad-leaved and narrow-leaved weeds. Out of total weeds present in the experimental field, 35.4 % were broad-leaved while 63.6% were narrow-leaved. The effects of weed management practices on weeds density were significant. Among all the treatments the minimum weeds density (4.0 m^{-2}) was recorded in tank mix treatment with herbicide Clidinafop propargyl + Carfentrazone-ethyl followed by Isoproturon + Carfentrazone-ethyl (4.7 m^{-2}) and Clidinafop propargyl + Metsulfuron- methyl (6.3 m^{-2}) while the maximum total weed density (14.9 m^{-2}) was recorded in weedy check (Table 1). Amongst singly applied herbicides, Carfentrazone-ethyl gave comparatively good results (6.9 m^{-2}) over other herbicides. These findings are in accordance with the results of Jat *at al.* (2014) who stated that weed population is lower in herbicides treated plots than control plot. As compared to weedy check, all the herbicide mixtures and alone application of Carfentrazone-ethyl significantly reduced the density of weeds. The effect of weed management practices on weed dry weight was also significant. The minimum weed dry matter weight of broad leaf weeds (11.9 g m^{-2}) was recorded in Clidinafop propargyl + Carfentrazone-ethyl mixture treated plots whereas the highest weed dry weight (241.5 g m^{-2}) was recorded in weedy check (Table 1). In case of narrow- leaf weeds, the minimum dry matter (17.6 g m^{-2}) was recorded with the same herbicide mixture. Amongst singly applied herbicides, Carfentrazone-ethyl resulted in the minimum dry matter followed by Metsulfuron-methyl, Isoproturon and Clidinafop propargyl. These findings are in conformity with those of Bharat and Kachroo (2007), who reported similar results with herbicide mixture. In general, significant reduction in weed dry weight with the application of Clidinafop propargyl + Carfentrazone-ethyl mixture might be due to more effectiveness of Carfentrazone-ethyl than Clodinafop-propargyl on broad leaved weeds. The tank mix solution of Clidinafop propargyl + Carfentrazone-ethyl herbicide also resulted in total highest weed control efficiency (84.9%) on weed flora; however it was found at par with tank mix herbicide Isoproturon + Carfentrazone-ethyl treatment. Higher weed control efficiency of these mixtures over their single application could be attributed to widening of spectrum of weed flora. Significant increase in dry matter was recorded with successive increase in nitrogen levels up to 120 kg ha^{-1}.

Table 1: Effect of herbicides and nitrogen on weed dynamics 65 days after sowing (Mean of two years)

Treatments	Weed density* (No. m^{-2})						Weed dry matter ($g\ m^{-2}$)			Weed-control Efficiency (%)		
	Broad-leaf		Narrow-leaf		Total		Broad-leaf	Narrow-leaf	Total	Broad-leaf	Narrow-leaf	Total
	OWC	WC*	OWC	WC*	OWC	WC*						
Herbicides												
T_1	75.3	8.7	138.5	11.9	221.7	14.9	89.3	152.2	241.5	0.0	0.0	0.0
T_2	53.7	7.4	24.8	5.0	90.7	8.7	55.9	48.8	104.7	37.4	67.9	56.6
T_3	22.3	4.8	51.3	7.2	53.5	7.7	24.3	53.9	88.2	72.8	64.6	63.5
T_4	56.7	7.6	19.5	4.5	68.2	8.3	56.7	51.3	118.0	36.5	66.3	51.1
T_5	19.0	4.4	33.3	5.8	47.5	6.9	21.5	61.8	86.3	75.9	59.4	64.3
T_6	23.7	4.9	20.2	4.5	41.2	6.5	24.3	29.3	57.6	72.8	80.7	76.1
T_7	20.3	4.6	13.0	3.7	38.8	6.3	21.3	27.9	52.2	76.1	81.7	78.4
T_8	11.3	3.4	13.7	3.8	21.7	4.7	13.7	28.1	47.8	84.7	81.5	80.2
T_9	9.3	3.1	8.7	3.0	15.3	4.0	11.9	17.6	36.5	86.7	88.4	84.9
CD (P=0.05)	2.9	-	5.2	-	6.5	-	2.0	3.5	6.1	2.4	3.5	2.2
Nitrogen (kg ha^{-1})												
60	23.3	4.9	18.5	4.4	43.8	6.7	31.7	36.3	85.6	64.5	69.3	64.6
90	25.0	5.0	19.0	4.4	47.2	6.9	32.2	37.3	91.2	63.9	69.1	62.2
120	27.5	5.3	19.3	4.4	50.3	7.1	35.1	38.1	93.2	60.7	67.3	61.4
CD (P=0.05)	1.5	-	NS	-	3.4	-	1.0	1.8	3.2	1.2	NS	1.1

OWC-Original Weed Count, WC Data subjected to* $\sqrt{x + 0.5}$ *transformation*

T_1 - weedy check, T_2 - Isoproturon 75%WP (1 kg ha^{-1}), T_3 - Metsulfuron- methyl 20% WG (20 g ha^{-1}), T_4 - Clidinafop propargyl 15% WP (400 g ha^{-1}), T_5 - Carfentrazone-ethyl 40% DF (50 g ha^{-1}), T_6 - Isoproturon + Metsulfuron- methyl 20% WG (1 kg + 20 g ha^{-1}), T_7-Clidinafop propargyl 15% WP + Metsulfuron- methyl (400 g + 20 g ha^{-1}), T_8 - Isoproturon + Carfentrazone-ethyl 40% DF (1 kg + 50 g ha^{-1}), T_9 - Clidinafop propargyl 15% WP + Carfentrazone-ethyl 40% DF (400 g + 50 g ha^{-1})

Crop Growth

Effect of weed management practices on plant height was significant over weedy check. The highest plant height was recorded with Clidinafop Propargyl + Carfentrazone-ethyl treated plots (103.7cm); it was found par with other treatments, whereas; the lowest plant height was recorded in weedy check (83.5 cm) (Hada *et al.* 2013). This indicated plants growing with effective weed control could attain higher height. However, significant increase in height (102.7 cm) was registered with the increase in N rate. The maximum crop dry matter (434.7 g) was also obtained in the same tank mix treated plots, which was at par with other tank mix herbicides except Isoproturon + Metsulfuron-methyl. Significant increase in plant height was recorded with increasing levels of N over 60 kg N ha^{-1} and maximum value was recorded with 120 kg N ha^{-1}. In singly applied herbicides Carfentrazone-ethyl produced higher dry matter (413.9 g) superior to 60 kg N ha^{-1} in respect of dry matter production. Similar results were reported by Singh *et al.* (2013). The increasing rates of N (120 kg N ha^{-1}) proved significantly in respect of dry matter production (414.6 g).over other levels of nitrogen.

Yield Attributes and Yield

Effects of weed management practices on number of tillers were significant and highest number (120.2 tillers/m row) of tillers was recorded in tank mix application of Clidinafop propargyl + Carfentrazone-ethyl followed by other herbicide mixture and singly used herbicides whereas it was recorded lowest (97.5 tillers/m row) in weedy check. This might be due to more effectiveness of these treatments on weeds that resulted in lower weed dry weight thus reduced weed crop competition that contributed to more number of tillers. These results are in agreement with the work of Jat *et al.* (2014). The highest number of grains/spike (46.1) was recorded in Isoproturon + Carfentrazone-ethyl followed by Clidinafop propargyl + Carfentrazone-ethyl whereas the lowest (38.3) in weedy check. These results are in accordance with the work of Iqbal (2003) who found that broad spectrum herbicides gave higher grains per spike.The highest number of grain/ear (2.2 g) were produced in plots treated with Isoproturon + Carfentrazone-ethyl and Clidinafop propargyl + Carfentrazone-ethyl but, it was at par with all other tank mix herbicides application except singly applied herbicides Isoproturon. Whereas; it was recorded lowest (1.5 g) in weedy check. Effect of weed management practices on 1000 kernel weight was significant and maximum test weight thousand grain weight (47.3 g) was recorded in Clidinafop propargyl + Carfentrazone-ethyl treated plots. This might have resulted due to effective weed control. These results are in agreement with the work Jat *et al.* (2014).

Table 2: Effect of herbicides and nitrogen on growth and yield attributes of *Triticum* wheat. (Mean of two years)

Treatments	Plant Height (cm)	Dry matter/m row (g)	Ear-bearing tillers/meter row	Grain/ spike (g)	Grains weight/ ear (g)	Test weight (g)	Grain Yield (q ha^{-1})	Straw yield (q ha^{-1})	Net returns (`. ha^{-1})	Benefit: cost ratio
Herbicides										
T_1	83.5	286.5	97.5	38.3	1.5	38.2	32.00	46.40	18117	2.19
T_2	96.5	378.0	111.2	40.7	1.7	40.7	40.69	59.00	37861	2.76
T_3	98.3	400.1	113.6	40.9	1.9	42.5	41.64	59.55	40234	2.84
T_4	97.4	385.2	109.3	41.8	1.8	42.7	41.66	59.16	39282	2.79
T_5	98.6	413.9	115.3	42.2	1.9	43.3	42.21	59.09	41001	2.85
T_6	98.2	406.3	114.5	42.1	2.0	43.1	46.55	64.70	51233	3.15
T_7	101.3	420.9	118.3	45.4	2.0	44.6	46.51	64.65	50343	3.10
T_8	100.5	421.3	118.7	46.1	2.2	45.6	47.78	65.46	53538	3.20
T_9	103.7	434.7	120.2	45.9	2.2	47.3	48.10	64.94	53782	3.20
CD (P=0.05)	3.8	21.2	6.5	2.1	0.06	1.9	3.2	7.1	2600	0.19
Nitrogen (kg ha^{-1})										
60	95.3	379.3	100.3	40.6	2.0	42.5	37.77	66.10	30388	2.52
90	96.1	398.6	114.9	44.8	2.1	45.8	42.46	74.73	40694	2.82
120	102.7	414.6	120.1	46.9	2.3	47.0	45.45	80.45	47073	2.99
CD (P=0.05)	2.0	11.2	3.4	1.1	0.03	1.0	1.7	3.8	1382	0.1

The graded increase in N levels from 60 to 120 kg ha^{-1} increased the ear bearing tillers/m row, grains/ear and test weight. Application of nitrogen has supplied adequate amount of nitrogen that helped in expansion of leaf area which might have accelerated the photosynthesis rate and in turn increased the supply of carbohydrates to plants. Similar results were reported by Singh *et al.* (2013). The significant increment in grain yield (48.10 q ha^{-1}) was recorded in the plots treated with tank mix herbicide Clidinafop propargyl + Carfentrazone-ethyl. This might be due to poor growth of weeds as it evident from the weed density and weed dry matter results. Bharat and Kachroo (2007) and Chauhan (2014) also reported the same results with use of herbicide mixture in wheat crop. Amongst singly applied herbicides, Carfentrazone-ethyl produced higher yield (42.21 ha^{-1}). The maximum straw yield (64.94 q ha^{-1}) was also recorded with Clidinafop Propargyl + Carfentrazone-ethyl herbicide mixture. The lowest grain and straw yields were obtained under weedy check which was due to the fact that weed plants in weedy check were under competitive stress for all resources. As yield is resultant of yield attributes, maximum value of these parameters due to less crop weed competition in Clidinafop Propargyl + Carfentrazone-ethyl treated plots resulted in the highest grain yield (Table 2). Similar trends were also observed in respect of straw yield. The increase in yield with these herbicides was due to significant reduction in growth of weeds which consequently resulted in the better expansion of yield components and thus gave high yield of wheat. With increasing levels of N the grain and straw yields of wheat increased significantly and maximum grain (45.45 q ha^{-1}) and straw (80.45 q ha^{-1}) yield were recorded under 120 kg N ha^{-1}. The grain and straws yield of wheat increased with, 120 kg N ha^{-1} by 20.3% and 21.7% over 60 kg N ha^{-1}, respectively. Increased availability of nitrogen was responsible for increased ear bearing tillers/plant, grain /ear and test weight which were responsible for better yield. Singh *et* *al.* (2013) and Pandey and Namdeo (2016) also reported significant increase in yield of wheat with nitrogen application.

Economics

Application of tank mix herbicide Clidinafop propargyl + Carfentrazone-ethyl was more economical with higher net returns (`. 53782 ha$^{-1}$) and benefit: cost ratio (3.20). The ascending rate of N up to 120 kg ha$^{-1}$ recorded significant increase in net returns (`. 47073) and benefit: cost ratio (2.99). This trend in economic returns was mainly owing to the treatment effect on the grain and straw yield. Singh (2016) also reported similar results in wheat. The best performing treatment (Clidinafop Propargyl 400 g ha^{-1} + Carfentrazone-ethyl 50 g ha^{-1}) proved significantly superior to rest of the treatments with higher net returns of `. 53782 ha$^{-1}$. Similar results were reported by Jat *et al.* (2003) and Singh (2012). Weedy check treatment resulted lowest net return `. 18117 and benefit: cost ratio 2.99. This was due to lower crop yield and no weed control.

From the results, it could concluded that weed control in wheat should be done by post-emergence application of Clidinafop propargyl 15% WP + Carfentrazone-ethyl 40% DF (400 g + 50 g ha^{-1}) at 32 days after sowing and the crop should be fertilizerd with 120 kg N ha^{-1} to get maximum yield and profits.

REFERENCES

Bharat, R. and Kachroo, D. (2007) Effect of different herbicides on mixed weed flora, yield and economics of wheat (*Triticum aestivum*) under irrigated conditions of Jammu. *Indian Journal of Agricultural Sciences* **77** (6): 383-386.

Chauhan, R.S. (2014) Effect of fertility and weed management on yield, nutrient uptake and economics of wheat. *Annals of Plant and Soil Research* **16** (4):304-307.

Hada, N., Nepalia, V. and Tomar, S. S. (2013) Influence of balanced nutrition, weed control and sowing methods of yield and nutrient uptake by durum wheat. *Annals of Plant and Soil Research* **15** (1): 19-22

Iqbal M., (2003) Efficacy of herbicides and row spacing on weeds and yield and yield components of wheat. *Sarhad Journal of Agriculture,* 1 pp 23-41.

Jain, V., Jain, N. and Kewat, M. C. (2014) Effect of application of post-emergence herbicides at different levels of available soil moisture content in irrigated wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **59** (1): 91-95.

Jat, R.S., Nepalia, V. and Jat, R.L. (2003) Effect of weed control and sowing methods on production potential of wheat*. Indian Journal of Agronomy* **48** (3): 192-195.

Jat, S. L., Nepalia, V., Chaudhary, J. and Singh, D. (2014) Effect of nitrogen and weed management on productivity and quality of durum wheat (*Triticum durum*). *Indian Journal of Agronomy* **59** (2): 281-285.

Meena, B.L. and Singh, R.K. (2013) Response of wheat (*Triticum aestivum*) to rice (*Oryza sativa*) residue and weed management practices. *Indian Journal of Agronomy* **58** (4): 521-524

nutrient omissions in alluvial soil. *Annals of Plant and Soil Research* **18**(3): 219-225.

Pandey, A, and Namdeo, K.N. (2016) Effect of nitrogen scheduling and doses on aerobic rice. Annals of Plant and Soil Research 18(2): 183-185.

Singh, R. J. (2012) Weed management in irrigated wheat (*Triticum aestivum*) with special reference to butter cup weed Ranunculus spp. in north-west Himalayas. *Indian Journal of Agricultural Sciences* **82** (8): 706-710.

Singh, V. (2016) Productivity, nutrient uptake and economics of wheat as affected by nutrient omissions in alluvial soil. *Annals of Plant and Soil Research 18(3):* 219-225.

Singh, V., Singh, S.P., Singh, S. and Shivay, Y.S. (2013) Growth, Yield and nutrient uptake by wheat (*Triticum aestivum*) as effected by biofertilizers, FYM and nitrogen. *Indian Journal of Agricultural Sciences* **83** (3):331-334.