Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 03, pp.5619-5622, March, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

ASSESSMENT OF APPLICABILITY AND EFFICACY OF POST EMERGENCE HERBICIDES THROUGH VARIOUS NOZZLE SYSTEMS IN WHEAT (*TRITICUM AESTIVUM* L.)

***[1]Singh, A.K., [2]Gautam, U. S., [1]Shrivastava, P., [3]Jai Singh and [1]Tomar, A. K.**

[1]Subject Matter Specialist, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Krishi Vigyan Kendra, Katni, Madhya Pradesh 483 442, India

[2]Principal Scientist, Zonal Project Directorate, Zone-VII, ICAR, JNKVV campus, Adhartal, Jabalpur, Madhya Pradesh 482 004, India

[3]Subject Matter Specialist, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Krishi Vigyan Kendra, Sidhi, Madhya Pradesh 486 661, India

ARTICLE INFO

Article History:
Received 20th December, 2013
Received in revised form
15th January, 2014
Accepted 19th February, 2014
Published online 25th March, 2014

Key words:
Droplet size,
Efficacy,
Nozzle,
Spray drift,
Weed management.

ABSTRACT

In India, the potential yield losses due to weeds in wheat are estimated upto 50 per cent depending upon degree of weed infestation, weed species and management practices. Due to improper application and stage, losses of herbicides increased manifold, be fond of significant reduction in crop yield with adverse effect on soil health. Nozzles used by farmers for herbicide spray, play a vital role in efficacy of herbicides. The efficacy of different nozzle systems *viz.* hollow cone, even flat fan, twin orifice flat fan, and full cone were assessed for the application of post emergence herbicides in irrigated wheat with a control treatment. The herbicides i.e. sulfosulfuron and 2,4-D were applied after 25 days after sowing of the crop, *cv.* HD 2864. Sprayer nozzle performance was evaluated in terms of weed density (m^{-2}) weed biomass, plant height (cm), number of effective tillers/plant, grains/spike, wheat grain yield and wheat straw, at farmers' field in Katni district of Madhya Pradesh during 2007-08 and 2008-09. Statistical analysis indicated that the nozzle type had significant effects on grain yield and dry biomass of weeds. The results revealed that the knapsack sprayer fitted with twin orifice flat fan nozzle for herbicide application, gave better weed control due to its comparatively less spray drift than the others. The weed density was observed highest in the herbicide applied using hollow cone nozzle due to its fine droplet size responsible for high spray drift and lowest in twin orifice flat fan nozzle followed by even flat fan and full cone nozzles respectively. The weed control efficiency of herbicides applied through full cone nozzle was also higher than the hollow cone nozzle. The yield attributes, grain and straw yield of wheat was noted high with twin orifice flat fan nozzle due to its better herbicide efficacy.

Copyright © 2014 Singh et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Weed management is an ever-present challenge to crop production. Weeds have the potential to usurp resources that would otherwise provide nourishment to growing crops or interfere with planting or harvesting operations. Because of these potential negative impacts, much research has been devoted to developing management strategies aimed at reducing weed populations, usually through mechanical disturbance or chemical applications (Zimdahl, 2004). Weeds are always associated with human endeavors and cause huge reductions in crop yields, increase cost of cultivation, reduce input efficiency, interfere with agricultural operations, impair quality, act as alternate hosts for several insect pests, diseases and nematodes. Weeds compete with crop plants for various inputs like water, nutrients, sunlight. The importance of their management seldom requires any mention especially under the present day high input farming systems. Weeds also interfere in the management of all the terrestrial and aquatic resources, create problems in the maintenance and inspection of various defense, electrical, railway and airport installations besides being a potential fire hazard in forests and cause health hazards like skin allergy, nasal diseases, etc.

The impact of weeds on the Indian economy estimated about two decades ago ranged from Rs. 20 to 28 billion (Sachan 1989, Sahoo and Saraswat 1988). A recent study suggests that proper weed management technologies, if adapted, can result in an additional income of Rs. 1,05,036 crores per annum (NRCWS, 2007). This figure would be greater if the direct and indirect impact of weeds on aquatic systems, forestry and industrial sites are also included. At a conservative estimate, an amount of Rs. 100 billion is spent on weed management annually in India, in arable agriculture alone. The potential yield losses due to weeds can be as high as about 65 per cent depending on the crop, degree of weed infestation, weed

***Corresponding author: Singh, A.K.,** *Subject Matter Specialist, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Krishi Vigyan Kendra, Katni, Madhya Pradesh 483 442, India.*

species and management practices (Yaduraju *et al*., 2006). Weed management is as old as agriculture itself, but the methods and concept of controlling weeds have changed over the years. The present weed control practices in India are characterized by intensive use of manual labour and animal power. Both of them are in short supply and are increasingly becoming uneconomical. Manual weeding, besides laborious is inefficient (not done on time in most cases) and always not practical because of adverse soil conditions. In addition, the manual labour traditionally being employed for weeding is gradually becoming scarce and expensive owing to rapid urbanization and industrialization. It has been noted that proportion of economically active population engaged in agriculture decreased from 64% in the year of 1990 to 57% in 2005 (IASRI, 2008).The weeds are more competitive with crops during the initial stages of their growth (2-6 weeks after planting). Controlling weeds during this time is very essential for realizing maximum crop yield. Because of this, chemical weed control method is rapidly gaining ground in the country, which on the other hand is raising several environmental concerns.

Currently wheat and rice crops account for about 60 and 20 per cent respectively of the total herbicide consumption in the country, the third crop being soybean which accounts for about 4 per cent. The data on herbicide consumption shows that they are being used in approximately 20 million hectares, which constitute about 10 per cent of the total cropped area (Yaduraju *et al.* 2006). Wheat production is directly affected by several factors and one of the most limiting is the problems of weeds. Yield losses of this crop estimated by researchers which varied between 30-50 per cent based on weed infestation (Pandey *et al.*, 1997). Crop suffers stress created by weeds through competition for moisture, nutrition, space, light and many other growth factors through competition and allelopathy. These tend to persist while man's efforts for eradication, resulting in direct loss to quantity and quality of the produce (Qasim and Foy, 2001; Gupta, 2004). Keeping in view the scarcity and high wages of labour, particularly during the peak period various post emergence herbicides are being used to control weed species in wheat crop and maximizing the seed yield (Singh *et al.*, 2003; Pandey *et al.*, 2006). The application of herbicidal mixture may be useful for the control of diversified broad and narrow leaved weed flora (Panwar *et al.* 1995, Singh *et al.* 2006).

Katni, a district of Madhya Pradesh state falls under *Kymore plateau and Satpura hills* agro climatic zone of the state. The zone is characterized by mixed red to medium black soil with silty clay to sandy loam in texture. Paddy and wheat are the main crops of *kharif* and *rabi* season with an area of 106800 and 65000 ha out of seasonwise total cultivated area of 137800 and 127200 ha respectively. Major weed species of wheat commonly observed are *Phalaris minor, Cynodon dactylon, Avena ludoviciana, Lathyrus aphaca, Vicia sativa, Echinochloa colona and Chenopodium album*. Out of the above, most noticeable weed species are *Phalaris minor* and *Lathyrus aphaca* and *Chenopodium album* with respect to weed density. At present, application of herbicide in wheat is being practiced in about one third of its total area for controlling weeds and to enhance the grain yield in the district, but the method of herbicide application to maximize the efficacy of various herbicides either alone or in combination against the grassy and broad leaved weeds in wheat crop, is still lacking. More than 85% farmers use 'knapsack sprayers' for spray of herbicides. The hollow cone nozzle fitted in the sprayer at the time of purchase, is commonly used for spray of pesticides and herbicides which affects the efficacy of herbicides in particular. Spraying parameters, such as spray volume and type of nozzle, play an important role in weed control effect because of their influence on covering and distribution of spray solution on plants surfaces (De Snoo & De Wit, 1993; Stainer, *et al.*, 2006). So, keeping in view the present study, was therefore, planned and conducted to find out the appropriate weed management options through various nozzle systems to maximize the herbicide efficacy for obtaining higher grain yield of wheat crop at farmers' field in Katni district.

MATERIALS AND METHODS

The proposed study was conducted at selected farmers' field of Katni district (Madhya Pradesh) in *rabi* season during 2007-08 and 2008-09. The crop was sown during 3rd to last week of November 2007 and 2008 respectively on the mixed red soil prevalent in the area. HD 2864 variety was used with a seed rate of 100 kg ha^{-1}. The soil was ploughed at desirable field condition and followed by single planking. Nitrogen (N), phosphorus (P) and potassium (K) were applied @ 100:60:40 kg ha^{-1} in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP) respectively. Whole P, K and half of the N were side dressed at the sowing time, while remaining N was top dressed in two splits after first irrigation and flowering stage respectively. The field was irrigated five times as the first irrigation was done 21 days after sowing and subsequent irrigations were applied as per crop water stages especially at tillering, pre-flowering, milking and grain development stage. All other agronomic practices except those under study were kept normal and uniform for all treatment combinations. The crop was harvested manually at physical maturity in IInd fortnight of April, 2008 and 2009. The trial was laid out at farmers' field (0.2 ha each) at five locations and farmers were treated as replications.

The experiment comprised five treatments *viz.* T_1 – no weed control, T_2 – weed control by post emergence herbicide application through hollow cone nozzle, T_3 – even flat fan nozzle, T_4 – twin orifice flat fan nozzle and T_5 – full cone nozzle. The post-emergence herbicides i.e. sulphosulphuron @ 25 g a.i. ha^{-1} and 2,4-D @ 0.5 kg a.i. ha^{-1} were sprayed at 25 days after sowing of wheat crop in moist field by "knapsack sprayer" using the above nozzles. Volume of spray was maintained uniform in all treatments and water was used @ 350 L ha^{-1}. Herbicide application was done in the morning, when wind was not blowing (wind was not moving leaves of surrounding trees) and spray height was maintained at a lower level of 30 to 40 cm above the ground. Data for weed density (m^{-2}) was recorded at 30 to 60 days after sowing (DAS) using standard procedures during the course of study. The counted weeds were cut near ground surface, stored in polythene bags and then recorded their biomass. The dry weight of weed was determined after oven-drying at 70°C till constant weight was achieved. The parameters *viz*. plant height (cm), number of effective tillers/plant, number of grains per spike, 1000 grain weight (g), grain yield (q ha^{-1}) and straw yield (q ha^{-1}) were recorded. Data was analyzed statistically according to Fisher's analysis of variance technique (Steel *et al*., 1997) and least significant difference (LSD) test at 5% probability level was applied to compare the treatments' means.

RESULTS AND DISCUSSION

Effect on weed density

It is evident from Table 1 that, under T_1 (no weed control), highest weed density (36.9 and 48.5 m^{-2}) was recorded at 30 and 60 DAS respectively. Among those treatments where herbicide was applied, maximum weed density (17.5 and 18 m^2) was observed in T_2 (hollow cone nozzle) both at 30 and 60 DAS followed by full cone, even flat fan and twin orifice flat fan nozzles respectively. Significant reduction in weed density was noticed in all the preceding treatments over T_2. The higher weed density in case of hollow cone nozzle was due to its fine droplet size and highest drift potential reduced the efficacy of herbicides. These findings are in agreement with those of Miller and Bellinder (2001) who have reported that hollow cone nozzles create fine spray because of fine droplet size which is responsible for highest drift potential.

Effect on weed dry weight

The data given in Table 1 indicates that the nozzles evaluated for herbicide application were significantly reduced weed dry weight over control (no weed control). Under the herbicide application treatments, maximum weed dry weight (12.23 m^{-2}) was noted in hollow cone nozzle, however, the minimum weed dry weight (1.92 m^{-2}) was found in the fields where twin orifice nozzle was used for herbicide application.

Less weed dry weight in case of twin orifice nozzle was noted due to less drift and higher herbicides accumulation in weed leaves resulted fast killing action as the height of spray was done at lower level above the ground. This observation is in agreement with findings of Jong *et al.* (2000) who reported that lowering the height of a boom sprayer from 70 cm to 30 cm reduced drift by 80% which, in turn, maximized the herbicide efficacy.

Effect on weed control efficiency

The data pertaining to weed control efficiency revealed that it was observed to be maximum (93.63 %) in twin orifice nozzle was used for herbicide application followed by even flat fan nozzle (90.34%). Under the T_5 treatment (full cone nozzle) weed control efficiency was noted to be 78.66 per cent, while, the minimum value was noted in case of hollow cone nozzle (59.41 %). The poor weed control efficiency of hollow cone nozzle was probably due to fine smallest droplets nearly of mist form increased the drift as the spray unintentionally reached outside the target area as fine droplets. These findings are similar to the research of Nuyttens *et al.* (2007) has reported that the mean droplet size may vary between the different nozzles at a similar spraying pressure. Nuyttens *et al.* (2006b) reported that the variation in drift between different nozzles under standard weather conditions can be even larger. Similar results were also reported by De Snoo and De Wit (1993) in their research trials conducted on drift estimation of pesticides sprayed by knapsack sprayers to ditches and ditch banks that nozzle type also affects the spraying angle, which on its turn may have an impact on drift.

Effect on yield attributes and yield

Significantly superior values under all the treatments were observed for plant height (cm), number of effective tillers/plant, grains per spike, and 1000 grain weight (Table 2)

Table 1. Effect of herbicides application through different nozzle systems on weed density, weed dry weight and weed control efficiency in wheat

Treatment	Weed density (m^{-2})		Weed dry weight at 60 DAS* (g m^{-2})	Weed control efficiency (%)
	30 DAS*	60 DAS*		
T_1	36.9	48.5	30.13	-
T_2	17.5	18.0	12.23	59.41
T_3	4.50	4.1	2.91	90.34
T_4	2.00	2.65	1.92	93.63
T_5	8.90	9.2	6.43	78.66
LSD (P = 0.05)	0.76	0.87	0.03	-

* Days after sowing

Table 2. Effect of herbicides application through different nozzle systems on yield attributes and yield of wheat

Treatment	Plant height (cm)	No. of effective tillers/plant	Grains/spike	Test weight (g/1000 grains)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	81.38	1.46	32.17	35.12	30.49	53.51
T_2	82.49	2.55	34.27	42.00	34.65	58.53
T_3	84.15	3.22	38.36	43.17	39.13	65.11
T_4	86.73	3.80	40.24	44.21	41.91	66.96
T_5	83.15	2.82	36.71	42.60	37.42	62.88
LSD (P = 0.05)	0.34	0.03	0.38	0.31	0.43	0.38

Table 3. Economic analysis of various weed control treatments

Treatment	Cost of cultivation (Rs ha^{-1})	Gross Return From grain		Gross Return from straw		Total Gross Return (Rs ha^{-1})	Net Return (Rs ha^{-1})	BC Ratio
		Grain Yield (q ha^{-1})	Return (Rs ha^{-1})	Straw Yield (q ha^{-1})	Return (Rs ha^{-1})			
T_1	9080	30.49	30490	53.51	5351	35841	26761	3.95
T_2	10255	34.65	34650	58.53	5853	40503	30248	3.95
T_3	10280	39.13	39130	65.11	6511	45641	35361	4.44
T_4	10280	41.91	41910	66.96	6696	48606	38326	4.73
T_5	10280	37.42	37420	62.88	6288	43708	33428	4.25

as compared to control. Among the herbicide application treatments, highest values of these parameters were noted in T_4 (twin orifice flat fan nozzle), however, the lowest in T_2 (hollow cone nozzle). The nozzles assessed for herbicide application, significantly influenced the grain and straw yield of wheat over control. The extent of increase in grain yield was noted to be 13.64, 28.34, 37.45 and 22.73 per cent in the preceding treatments over control. The straw yield was increased by 9.38, 21.68, 25.14 and 17.51 per cent with preceding treatments over control. Twin orifice nozzle was most superior with respect to weed control as a result of that highest grain and straw yield of 41.91 and 66.96 q ha^{-1} respectively noted with the said treatment (Table 2). The hollow cone nozzle showed poor performance in herbicide efficacy among all the nozzles, hence the lowest grain and straw yields (34.65 and 58.53 q ha^{-1}) were recorded. The findings are similar to those of Renata, K. and Krzysztof, D. (2013) who has investigated two types of nozzle for spray of herbicide formulations in winter wheat which showed that the spray performed by extended range flat nozzle resulted in better herbicide efficacy due to size of droplets and uniform distribution on plant surface.

Economic analysis

It is evident from Table 3 that the net return and BC ratio were recorded to be highest in T_4 (twine orifice flat fan nozzle). An additional net return of Rs 11565 ha^{-1} was found with the said treatment which leads to a remarkable difference (0.78) in BC ratio over control. These results show the efficacy and suitability of the twine orifice flat fan nozzle for herbicide application. Even flat fan and full cone nozzles were also stemmed remarkable difference in net return and BC ratio over control. The net return under T_2 (hollow cone nozzle) was, however, higher as compared to control but the BC ratio was same due to increased cost of cultivation which is indicative of its poor herbicide efficacy thus the use of hollow cone nozzles practiced by the farmers for herbicide application is unsuitable, hence it should be avoided for the above purpose.

On the basis of above results, it may be concluded that the type of nozzles for spray of post emergence herbicides in wheat, may create significant difference in terms of herbicide efficacy which influences weed density and as a result of that yield is significantly affected. Hollow cone nozzles proved high spray drift resulted in poor herbicide efficacy and less weed control efficiency; hence the study suggests inappropriateness of above nozzle for herbicide application. Twine orifice flat fan nozzle performed well for post emergence herbicide spray followed by even flat fan and full cone nozzles.

Acknowledgments

The authors are thankful to the in charge, library and other officials of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing library and other facilities for the study. We also thanks to Indian Council of Agriculture Research for provide hundred per cent budget to KVK scheme under which the study was conducted. We are also thankful to the farmers for their support in successful completion of the study.

REFERENCES

De Snoo, G.R. and P.J. de Wit. 1993. Pesticide drift from knapsack sprayers to ditches and ditch banks. Pages 879-884 *in* Proceedings of the Brighton Crop Protection Conference – Weeds, Farnham UK: British Crop Protection Council.

Gupta, O.P. 2004. Modern weed management 2nd Ed. Agrobios Jodhpur, India. Pp. 18-23.

IASRI. 2008. Total Agricultural and Economically Active Population. Agricultural Research Data Book. IASRI, New Delhi-12. Pp. 54-56.

Jong, A de. Michielsen J.M.G.P., Stallinga, H, and Zande J.C. 2000. Effect of sprayer boom height on drift. Pages 919-930 *in* Proceedings, 52nd International Symposium of Crop Protection. Gent, Belgium, 9 May 2000, Part II.

Miller, A. and R. Bellinder. 2001. Herbicide application using a knapsack sprayer. Rice-Wheat Consortium for the Indo-Gangetic plains, New Delhi-110 012, Pp 12.

NRCWS. 2007. NRCWS - Perspective Plan Vision 2025. National research Centre for Weed Science, Jabalpur, Madhya Pradesh.

Nuyttens, D., K. Baetens, M. de Schampheleire, and B. Sonck. 2007. Effect of nozzle type, size and pressure on spray droplet characterstics. Biosystems Engineering. 97: 333-345.

Nuyttens, D., M. de Schampheleire, W. Steurbaut, K. Baetens, P. Verboven, B. Nicolai, H. Ramon and B. Sonck. 2006b. Experimental study of factors influencing the risk of drift from field sprayers, Part 2: spray application technique. Aspects of Applied Biology. 77: 331-339.

Pandey A.K., Gopinath K.A. and Gupta H.S. 2006. Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat (*Triticum astivum*). Indian J. Agron. 51 (2): 135-138.

Pandey J. and Singh R. 1997. Weed control in wheat is key to higher production. Indian farming, 47 (8): 4-7.

Panwar R.S., Rathi S.S., Malik R.S. and Malik R.K. 1995. Effect of broad spectrum herbicides alone and in combination with chlorimuron on weed control in wheat. Indian J. Weed Sci. 27:148-151.

Qasim, J.R., Foy C.L. 2001. Weed allelopathy; its ecological impact and future prospect. J. Crop Prod. 4: 43-120.

Renata, K. and Krzysztof, D. 2013. The influence of selected spraying parameters on two formulation of sulfonylurea herbicides effect. Journal of Central European Agriculture. 14(1), 42-51.

Sachan, G.C. 1989. Pesticides in agriculture. Indian Farmers Digest. 22:9-13.

Sahoo, K.M. and Saraswat, V.N. 1988. Magnitude of losses in the yield of major crops due to weed competition in India. Pesticides Information. 14:2-9.

Singh R.P., Mukharjee D., Singh, R.K. and Sinha A.K. 2003. Bioefficacy of herbicides in late sown wheat (*Triticum astivum*). Indian J.Agron. 48: 196-198.

Singh, R., Sen D., Rana, R.S., Kumar S., Singh V.K. and Singh R.G. 2006. Efficacy of dicambna alone and in combination with isoproturon on wheat (*Triticum astivum*) and associated weeds. Indian J. Agron. 51: 139-141.

Stainer, C., Destain, M.F., Schiffers, B., Lebeau, F. 2006. Droplet size spectra and drift effect of two phenmedipham formulations and four adjuvants mixtures. Crop Protection, 25 (12), 1238-1243.

Steel, R.G.D., Torrie, J.H., Dickey, D. 1997. Principles and procedures of Statistics: A Biometrical Approach. 3rd Ed. McGraw Hill Book Co. Inc. New York., Pp. 172-77.

Yaduraju, N.T., Prasad Babu M.B.B. and Poonam Chandla. 2006. Herbicide Use. Pages 192-210 i*n* Agriculture and Environment. Swaminathan, M.S. and Chadha, K.L. (Eds.). Malhotra Publishing House, New Delhi, India.

Zimdahl, R.L. 2004. Weed–crop competition: A review. Blackwell Publishing, Oxford, UK.

****