Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 2268-2271
Received: 10-03-2020
Accepted: 12-04-2020

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Effect of pre and post emergence herbicides on nutrients uptake and soil microflora in onion

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Abstract
A field investigation entitled "Effect of pre and post emergence herbicides on nutrients uptake and soil microflora in onion (*Allium cepa* L.)" was carried out at AICRP on weed management field of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* season of the year 2018-19 with an objective to study the effect of herbicides on nutrient uptake and soil microflora in onion. The experiment was laid out in randomized block design with nine treatment replicated thrice. The soil of the experimental field was fairly uniform and well levelled characterized as clay loam in texture, having slightly alkaline pH reaction (7.7), low organic carbon status (0.41%), low nitrogen content (197.21 kg ha^{-1}), medium available phosphorus content (18.76 kg ha^{-1}) and rich in available potassium (366.49 kg ha^{-1}). Onion (Akola Safed) was transplanted on 14th December 2018 at 20×10 cm spacing with fertilizer dose of 100:50:50 NPK kg ha^{-1}. The results revealed that there was a significant differences in uptake of major nutrients N, P and K by crop and maximum total nitrogen, phosphorus and potassium uptake of 59.02, 17.70 and 29.51 kg ha^{-1} respectively was recorded in weed free treatment followed by Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T_3) (54.60, 16.94 and 26.36 NPK kg ha^{-1}) and treatment Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T_6). As regards to uptake by weed, weedy check treatment showed maximum uptake (62.93, 19.70, 36.12 NPK kg ha^{-1}) of major nutrients than all other treatments of chemical herbicides and weed free plots. Effect of herbicides after spraying significantly influenced the population of soil microorganism's *viz*., bacteria, fungi and actinomycetes as compared to their population before herbicide application. But at the time of harvest of the crop the microbial population with all the treatments attained slight higher level.

Keywords: Onion, nutrient uptake, pre-emergence, post-emergence, soil microflora

Introduction

Onion is one of the most important commercial bulbous vegetable crop belonging to family Amaryllidaceae grown from ancient times having more demand in domestic market as well as in export market due to its ability to fetch handsome foreign exchange. Among various constraints faced by onion growing farmer community, weed pose serious problem in onion cultivation which reduces bulb yield production to the extent of 40-80% (Vishnu *et al.*, 2014) [14]. Due to inherent characteristics of onions such as short stature, non- branching habitat, spare foliage, close planting of transplant, shallow root system of seedling, extremely slow initial growth frequent irrigation provide congenial condition for weed growth and conventional method weed control quite ineffective against uprooting of weed (Ibrahim *et al*., 2011) [3]. Weed interfere with efficiency of fertilizer utilization by crops plants because a sizeable portion of the fertilizer added to the soil is used by weed. Weeds are regarded as pest of crops because they lower down the productivity, increase the cost of production and inferior the quality of produce. The quantities of growth factors used by weeds are thus unavailable to the crop.

Management of weeds is considered to be an important factor for achieving higher productivity. Yield loss occurs up to 40% to 80% due to weed competition in onion (Channapagoudar and Biradar, 2007) [1]. Weeds also pose severe problems for crop husbandry and infest fallow land, reduce soil fertility and moisture conditions and develop a potential threat to the succeeding crops (Khan *et al*., 2003) [5]. Weed generally compete with the crop plants for nutrients and depletes 30-40 per cent of applied nutrients from the soil. There is severe competition among weeds and crops for major nutrients like N, P and K. Kour *et al.* (2014) [6] reported that the maximum removal of N, P and K by weeds was recorded with weedy check due to higher dry matter of weeds which enabled them to absorb more nutrients. Herbicides not only control the weeds timely and effectively but also offer great scope for minimizing the cost of weed control irrespective of the situation.

The conventional method of weed control (hoeing/ hand weeding) are very laborious, expensive and time consuming and needs to be often repeated at different intervals. Use of pre and post emergence application of herbicides would make herbicidal weed control more acceptable to farmers which will not change the existing agronomic practices but will allow for complete management of weeds. Chemical weed management by using pre emergence and post emergence herbicides can lead to the efficient and cost effective control of weeds during critical period of crop weed competition, which may not be possible in manual or mechanical weeding due to its high cost of cultivation (Triveni *et al.*2017) [13].

Though herbicides have emerged as an important tool in management of weeds. Herbicides use is increasing throughout the globe due to increasing cost, choice of application of herbicides, quick weed control in crop and non crop areas etc. But herbicides are chemical in nature therefore excessive and repeated use may pose residue problems and adverse effect on soil microflora and its continuous use can build soil resistance against particular herbicide. Nowadays, soil health and microbial diversity have become vital issues for the sustainable agriculture. Loss of microbial biodiversity can affect the functional stability of the soil microbial community and soil health. Generally, negative effects of herbicides on the population level or composition of species are decreased for a while but subsequently improves. Beneficial organism known to be affected negatively by specific herbicides includes nitrogen fixing bacteria (Rhizobium) and some mycorhizal fungi. Actinomycetes are relatively resistant to herbicides and affected at high concentration only. Fungi are probably the more sensitive to the majority of herbicides than are bacteria. The present investigation was therefore planned with an objective to study the effect of herbicides on nutrient uptake and soil microflora in onion (*Allium cepa* L.).

Materials and Method

The present field experiment was conducted during *Rabi* season of the year 2018-19 at the research farm of AICRP-Weed Management, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) in Randomized Block Design with three replication having nine different treatments of weed management including Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE (T_1), Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE (T_2), Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T_3), Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE (T_4) are the herbicide with combine (pre-mix) formulation with different concentration of active ingredient, Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE (T_5), Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T_6), Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE (T_7), 2 Hand weeding 25& 45 DAT (T_8) and weedy check(T_9). The soil of experimental field was fairly uniform and levelled characterized as clay loam in texture, having slightly alkaline pH reaction (7.7), low organic carbon status (0.41%), low nitrogen content (197.21 kg ha^{-1}), medium available phosphorus content (18.76 kg ha^{-1}) and high available potassium (366.49 kg ha^{-1}). Onion (Akola Safed) was transplanted on 14^{th} December 2018 at 20 × 10 cm spacing with fertilizer dose of 100:50:50 NPK kg ha^{-1}. The crop was harvested on 9^{th} April, 2019. The application of herbicide was done as per the treatments with manually operated knapsack sprayer attached with a flood jet nozzle. After calibrating the sprayer, water volume used was 700 lit. per ha. for PE and 500 lit. per ha. for PoE. The total nitrogen in the composite crop and weed samples were estimated by modified Kjeldhal's method (Jackson, 1967) [4] and expressed in percentage on dry weight basis. Phosphorous content in the plant and weed samples was determined by Venadomolybdate phosphoric yellow colour method using spectrophotometer at 470 nm as described by Jackson (1967) [4] and was expressed as percentage of phosphorous. Potassium content in the plant and weed samples were determined by Flame photometer method and were expressed as percentage potassium. Nitrogen, phosphorus and potassium percent and total dry weight of weeds were used to calculate the total N, P, and K uptake at harvest and was expressed as kg ha^{-1}. Serial dilution plate technique was used for isolation and enumeration of soil fungi, actinomycetes and bacteria as described by Pahwa and Prakash (1996) [8].

Results and Discussion

Nutrients uptake by crop

The data presented in Table 1 showed that there was a significant differences in uptake of major nutrients N, P and K. Maximum total nitrogen, phosphorus and potassium uptake of 59.02, 17.70 and 29.51 kg ha^{-1} respectively was recorded in weed free treatment with 2 HW 25& 45 DAT (T_8) followed by Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T_3) (54.60, 16.94 and 26.36 NPK kg ha^{-1}) and treatment Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T_6). The result showed that the NPK uptake by plant was highest in treatment weedy free (T_8), The higher nitrogen uptake in weed free treatment was observed due to less weed infestation, competition of weed was low and more production of dry matter and higher onion bulb yield due to optimized utilization of available resources as compared to other treatments. Similar results were also reported by Sable *et al*. (2013) [11]. However, in weedy check treatment the rate of uptake of NPK by plants was very slow where N,P,K uptake was only 20.66, 5.76, 9.88 NPK kg ha^{-1}. This is due to weed suppress the vegetative growth of onion plants by competition to light, moisture and nutrient. Similar results were also reported by Sable *et al.* (2013) [11].

Nutrients uptake by weed

Data regarding nitrogen, phosphorous and potassium uptake (kg ha^{-1}) by weeds as influenced by different treatments are presented in Table-1 which clearly indicated that weedy check treatment showed maximum uptake (62.93, 19.70, 36.12 NPK kg ha^{-1}) of major nutrients than all other treatments of chemical herbicides and weed free plots. This was mainly due to heavy infestation of weeds which took up enormous amount of NPK from soil in weedy check as nutrient uptake and which was directly governed by dry matter production of weeds. The same kind of result was also reported by Sable *et al*. (2013) [11]. Among the herbicidal treatments Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T_3) (10.45, 2.84, 5.69 NPK kg ha^{-1}) and treatment Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T_6) recorded minimum uptake of nutrients by weeds and was found at par with each other. Mahadevaiah and Karunasagar (2014) [7] also reported that the weedy check registered highest nitrogen, phosphorus and potassium uptake by weeds in baby corn. This results are also reported earlier by Kour *et al*. (2014) [6] where maximum removal of N, P and K by weeds was recorded with weedy check due to higher dry matter of weeds which enabled them to absorb more nutrients and further, pre-emergence application of Pendimethalin 24% + Oxyfluorfen 4% ZE

@600+102.5 g a.i./ha PE resulted in significantly lower N, P and K uptake by weeds which was followed by pre-emergence application of Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE.

Effect on soil microflora (Bacteria, Fungi and Actinomycetes)

The effect on different soil microflora *viz*. bacteria, fungi and actinomycetes due to different weed control treatments was studied and the data is presented in Table-2 which showed that before sowing there were non-significant differences in all the microbial population. There was decrease in population of bacteria after spraying of herbicides. But it was recovered at harvest stage of the crop with slight increase in population. Higher count of all this microflora was recorded in weedy check treatment as no chemicals was used in these treatments. However this was comparable with the count as observed in weed free treatments. Effect of herbicides after spraying significantly influenced the population of soil micro-organisms *viz*., bacteria, fungi and actinomycetes as compared to their population before herbicide application. But at the time of harvest of the crop the microbial population with all the treatments attained the slightly increased level as compared to initial observation i.e. before transplanting. It was clear that the persistence of herbicide on soil microbes was for a temporary period. The increase in microbial population might be due to after decomposition of herbicide, there is activation of different function group attached to herbicide. After decomposition of herbicide it release carbon molecules which are useful for enhancing microbial population in soil. It might be due to the degradation of herbicides may be serving as carbon source for growth of microbes. The microbial population started to regain after the weeds were killed by the herbicides and got mixed in the soil during this period and these might have served to increase the nutrients. The present study showed that there is a temporary suppression in population of beneficial micro organisms but with passage of time the population again recovered in these biological soil environments. The treatment pendimethalin 24% + oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha (T_4) recorded minimum fungal,bacteria and actinomycetes count. This might be due to application of herbicide in higher concentration. It was in conformity with the results of Pal *et.al*. (2009) [9] and Ghosh *et al.* (2012) [2]. Poddar *et al*. (2017) [10] and Trimurtulu *et al*. (2015) [12].

Table 1: Nutrients uptake (N, P and K) by crop and weed as influenced by different weed control treatments in onion

Treatments	Total nutrients uptake by onion bulb Kg ha^{-1}			Nutrients uptake by weed Kg ha^{-1}		
	N uptake	P uptake	K uptake	N uptake	P uptake	K uptake
T_1 - Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE	38.30	8.81	17.63	15.90	4.45	7.96
T_2 - Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE	41.14	10.66	18.28	13.49	3.93	6.74
T_3 - Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE	54.60	16.94	26.36	10.45	2.84	5.69
T_4- Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE	44.98	11.24	20.88	12.23	3.05	6.10
T_5- Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE	34.08	7.86	15.73	14.32	4.09	8.19
T_6- Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE	49.12	13.55	22.01	11.20	2.93	5.87
T_7- Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE	38.61	9.92	17.01	16.77	7.46	11.19
T_8- Two HW (25 & 45 DAT)	59.02	17.70	29.51	-	-	-
T_9-Weedy Check	20.66	5.76	9.88	62.93	19.70	36.12
S.E(m)±	2.78	0.75	1.48	1.16	0.34	0.73
C.D. at 5%	8.33	2.27	4.45	3.48	1.04	2.19

Figures in parenthesis are original values

Table 2: Microbial count (Bacteria, Fungi and Actinomycetes) as influenced by different weed control treatments in onion at periodical growth stages

Treatments	Bacteria (cfu g^{-1} soil × 10^7)			Fungi (cfu g^{-1} soil × 10^4)			Actinomycets (cfu g^{-1} soil × 10^6)		
	Before sowing	After spray	At harvest	Before sowing	After spray	At harvest	Before sowing	After spray	At harvest
T_1 - Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE	12.27	11.20	27.42	10.00	8.19	23.43	8.30	8.07	25.70
T_2 - Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE	10.25	9.10	25.05	10.47	7.13	22.14	8.50	8.24	24.41
T_3 - Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE	11.55	7.60	24.79	10.24	6.24	23.19	8.77	7.31	23.50
T_4- Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE	11.86	6.83	20.88	10.54	5.26	19.48	8.53	6.42	20.20
T_5- Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE	12.68	9.77	25.39	10.47	8.08	22.18	8.27	8.10	24.45
T_6- Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE	12.50	7.63	22.29	10.40	7.78	22.53	8.53	8.30	28.31
T_7- Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE	10.43	11.60	28.33	10.13	10.95	21.77	8.03	7.63	22.26
T_8- Two HW (25 & 45 DAT)	11.60	9.70	21.77	10.37	8.80	18.57	8.70	8.30	21.03
T_9-Weedy Check	13.10	14.33	30.60	10.43	13.59	25.04	8.73	18.60	29.97
S.E(m)±	0.79	0.57	2.03	0.76	0.66	1.52	0.64	0.55	2.02
C.D. at 5%	NS	1.72	NS	NS	1.99	NS	NS	1.67	6.07

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