The Pharma Innovation Journal 2021; 10(8): 1426-1429

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 1426-1429

www.thepharmajournal.com
Received: 14-06-2021
Accepted: 21-07-2021

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Efficacy of GOD H007 formulation in wastelands of Himachal Pradesh

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Abstract
A field experiment was conducted during *kharif* 2019 at the Research Farm of Department of Agronomy, College of Agriculture CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to study the efficacy of new herbicide combination product GOD H007 (containing glyphosate 40% and pyrithiobac sodium 3%) for managing weeds in wastelands. The experiment was laid out in Randomized Block Design with three replications, and consisted of seven weed control treatments including GOD H007 at 860, 882 and 903 g/ha, pyrithiobac sodium 62.5 g/ha, glyphosate 820 g/ha, hand weeding and a weedy check. Application of this new herbicide combination product GOD H007 903 g/ha though remaining statistically alike with glyphosate 820 g/ha, resulted in significantly lowest total weed density and total weed dry matter at all the stages of observation except that at 30 days after spray (DAS) at which hand weeding proved to be a superior treatment. These three treatments also recorded higher weed control efficiency. However, significantly highest fresh and dry herbage yield at 60 DAS was recorded with the application of pyrithiobac sodium 62.5 g/ha. Application of this new herbicide GOD H007 903 g/ha showed promise to be effective for managing weeds in grassland.

Keywords: GOD H007, weed control, wasteland, glyphosate, pyrithiobac sodium

1. Introduction
Wastelands are lands which are unproductive, unfit for cultivation, grazing and other economic uses due to rough terrain and eroded soils. The lands which are waterlogged and saline are also termed as wastelands. The loss of fertility followed by erosion also leads to the conversion of marginal forest lands into wastelands. In the absence of land management policy, geomorphic processes become active due to which soil layers are eroded and transported, making these lands infertile, stony and useless. This is one of the pressing problems of one country as loss of soil has already ruined large amounts of cultivable lands. If it remains unchecked it will affect the remaining lands. Hence, conservation of soil, protecting the existing cultivable lands and reclaimable the already depleted wastelands figure predominantly among the priority tasks of planning for the future. Glyphosate and paraquat are most commonly used herbicides in wastelands to free them from obnoxious vegetation. However, newer products are required to be developed and recommended to broaden the spectrum of weed control especially when some of the prevalent herbicides are facing imminent bans by union government. GOD HOO7 64.5% Soluble Grains (SG) is a combination product having glyphosate 40% and pyrithiobac sodium 3% SG. Active ingredients of this new herbicide combination product inhibit the plant enzymes acetolactate synthase (ALS) and 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) which are needed for protein synthesis and have been recommended for use alone for control of weeds in wastelands. These non-selective post-emergence herbicides control a wide range of wastelands weeds. However little information is available with regards to their efficacy when used as a herbicide combination product. In view of the above facts the present investigation was undertaken to study the efficacy of this new combination product GOD H007 for controlling weeds in wastelands.

Materials and Methods
A field investigation was carried out in wastelands located near the Experiment Farm of Department of Agronomy of CSKHPKV, Palampur (32° 6' N latitude, 76° 3' E longitude) during *kharif* 2019. The soil of the experimental site was silty clay loam in texture, acidic in reaction (pH 5.6), low in available nitrogen (230 kg/ha), and medium in available phosphorus (15.8 kg/ha) and potassium (192 kg/ha).

Seven weed control treatments consisting of three doses of this new herbicide combination product GOD H007 860, 882 and 903 g/ha, pyrithiobac sodium 62.5 g/ha, glyphosate 820 g/ha, a hand weeding and weedy check were tested in Randomized Block Design with three replications. Herbicides were applied using 600 liters of water/ha with a flat fan nozzle attached to a knapsack sprayer as per schedule. Weed count and weed dry weight were recorded from two spots using a quadrate of 50 x 50 cm and expressed as number and g/m^2, respectively. The data on weed count and weed dry weight were subjected to square root transformation ($\sqrt{x+0.5}$) before statistical analysis which was done as per Gomez and Gomez (1984) [4]. Weed control efficiency was calculated as per formula given by Mishra and Tosh (1979) [7].

$$\text{Weed control efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where DWC- Weed Dry Weight (g/m^2) in control plot, and DWT- Weed Weight (g/m^2) in treated plot

Results and Discussion

The dominant weed flora in the experimental area consisted of *Syndrella riodiflora, Parthenium hysterophorus, Hypoctes phyllostachya, Erigeron canadensis, Cynodon dactylon, Bidens pilosa, Ageratum conyzoides, Polygonium alatum* and *Centella sp.. Commelina benghalensis, Digitaria sanguinalis* and *Phylanthus niruri* were also present in small number. Similar type of flora has been observed by Angiras (2014) [1] in wastelands under mid hill condition of Himachal Pradesh.

Different weed control treatments significantly influenced the total weed count at different stages of observation (Table 1). Owing to reduction in species-wise weed count, GOD H007 903 g/ha resulted in significantly lower density of total weeds except at 15 DAS where hand weeding was significantly superior. Application of GOD H007 903 g/ha behaving statistically similar with glyphosate 820 g/ha resulted in significantly lower total weed count at all the stages of observation as compared to other treatments. However, glyphosate 820 g/ha also behaved statistically similar with GOD H007 882 g/ha in this regard at all the stages of observation. Pyrithiobac sodium was least effective herbicide. The superior performance of each of these treatments over unweeded check could be described to their contribution to control or suppress these weeds partially or completely. These findings are in direct conformity with those of Kundu *et al*. (2018) [6] with respect to superiority of herbicides to control weeds. Ghosh *et al*. (2002) [3] have also reported that the weeds in non-cropped land were effectively controlled with the application of glyphosate isopropylamine salt 18% + 2, 4-D isopropyl amine salt 9% (ready mix) at 4.5 L ha^{-1}. At all the stages of observation effects of GOD H007 and glyphosate were significantly better than other treatments and brought better suppression of weeds. The results were in conformity with the earlier finding of Kumar *et al*. (2017) [5].

Table 1: Effect of treatments on weed count (No./m^2) and weed biomass (g/m^2) at different stages of observation

Treatment	Dose (g/ha)	Weed count				Weed biomass			
		15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
GOD H007 64.5% SG	860	12.17 (148.00)	11.15 (124.00)	12.07 (145.33)	13.33 (177.33)	10.77 (115.67)	10.75 (115.17)	11.82 (139.32)	14.10 (198.49)
GOD H007 64.5% SG	882	11.15 (124.00)	9.79 (96.00)	10.94 (120.00)	12.33 (152.00)	9.87 (96.95)	9.79 (95.61)	10.28 (105.49)	12.63 (159.28)
GOD H007 64.5% SG	903	10.08 (101.33)	8.34 (69.33)	9.10 (82.67)	10.72 (114.67)	8.86 (78.27)	7.63 (58.36)	8.24 (67.52)	11.20 (124.87)
Pyrithiobac sodium 10% EC	62.5	13.87 (192.00)	14.62 (213.33)	15.80 (249.33)	17.24 (297.33)	13.90 (193.93)	14.88 (221.33)	15.79 (248.92)	17.22 (296.12)
Glyphosate 41% SL	820	12.95 (168.00)	9.51 (90.67)	10.22 (104.00)	11.61 (134.67)	12.32 (151.25)	8.11 (65.55)	8.73 (75.81)	11.89 (140.99)
Hand weeding	-	5.02 (25.33)	11.27 (126.67)	15.16 (229.33)	17.05 (290.67)	4.73 (22.59)	10.97 (120.29)	14.66 (214.44)	18.03 (324.92)
Weedy check	-	15.92 (253.33)	18.12 (328.00)	19.46 (378.67)	20.83 (433.33)	16.52 (272.89)	17.99 (324.16)	18.82 (354.24)	20.50 (420.72)
S.Em±		0.42	0.46	0.36	0.35	0.47	0.49	0.34	0.28
LSD (P=0.05)		1.30	1.40	1.10	1.08	1.45	1.51	1.05	0.86

Values in parentheses are the means of original values; Data transformed to square root transformation ($\sqrt{x+0.5}$); DAS: days after spray

Total weed dry weight followed the similar trend as of the total weed count. The data presented in Table 1 reveal that all the treatments were significantly superior over weedy check treatment in reducing the total weed dry matter accumulation as compared to weedy check. Owing to reduction in species-wise weed dry weight, GOD H007 903 g/ha behaving statistically similar with glyphosate 820 g/ha resulted in significantly lower total dry weight at all the stages of observation except at 15 DAS where, hand weeding was significantly superior over GOD H007 903 g/ha. Total dry matter accumulation decreased gradually from before spray to 30 DAS and it increased thereafter up to the final stage of observation in all chemical treatment except pyrithiobac sodium 62.5 g/ha. These results are in close conformity with the findings of Corbett *et al*. (2004) [2]. It might be due to the fact that translocative nature of herbicides take time to reach the site of action and thus at 30 DAS there was maximum reduction in weed dry weight. Application of GOD H007 882 g/ha was the next best treatment in reducing total weed dry matter accumulation as compared to other treatments at all the stages of observation.

The data on effect of different treatments on weed control efficiency followed the trend similar to the total weed count and total weed biomass with GOD H007 903 g/ha showing highest efficiency at all the stages of observation in wastelands (Table 2). This treatment was followed by glyphosate 820 g/ha and GOD H007 882 g/ha, whereas, pyrithiobac sodium recorded lowest weed control efficiency at all the stages of observations. This was because pyrithiobac sodium is effective in controlling only broadleaved weeds

with little or no effect on grassy weeds. All the other weed control treatments were also superior to weedy check in terms of weed control efficiency.

Table 2: Effect of treatments on weed control efficiency (%) in wasteland

Treatment	Dose (g/ha)	Weed control Efficiency			
		15 DAS	30 DAS	45 DAS	60 DAS
GOD H007 64.5% SG	860	57.61	74.77	60.67	64.78
GOD H007 64.5% SG	882	64.47	81.60	70.22	71.19
GOD H007 64.5% SG	903	71.32	90.99	80.94	81.69
Pyrithiobac sodium 10% EC	62.5	28.93	22.93	29.73	22.29
Glyphosate 41% SL	820	44.57	89.16	78.60	77.55
Hand weeding	-	91.72	75.42	39.46	39.41
Weedy check	-	0.00	0.00	0.00	0.00

DAS: days after spray

The data on effect of different weed control treatments on chemical properties of soil (pH, electrical conductivity and available nitrogen, phosphorus & potassium contents) has been given in Table 3. The data revealed that pH and electric conductivity was not influenced significantly by weed control treatments, while the available nitrogen, phosphorus and potassium contents in soil were significantly influenced. Significantly higher values of available nitrogen, phosphorus and potassium were recorded under GOD H007 903 g/ha though this treatment remained statistically similar with all other chemical treatments except pyrithiobac sodium 62.5 g/ha in case of available potassium.

The data on effect of treatments on biological properties of soil (Table 4) revealed that weed control treatments had significant influence on the count of bacteria and fungi, actinomycetes in the soil.

Application of GOD H007 903 g/ha and glyphosate 820 g/ha resulted in significantly higher count of bacteria, fungi and actinomycetes in soil while lower values were recorded in weedy check and hand weeding treatment. Application of this new herbicide combination product GOD H007 as well as glyphosate was effective in killing the weeds as well as grasses and these microbes flourished on the dead biomass of weeds and grasses indicating that the new herbicide combination is safe for soil microbes. These findings are in dose conformity with the findings of Poddar *et al*. 2014 [8].

Table 3: Effect of treatments on chemical properties of wasteland soil

Treatment	Dose (g/ha)	pH	EC (ds/m)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
GOD H007 64.5% SG	860	6.08	0.15	216.53	15.80	150.29
GOD H007 64.5% SG	882	6.11	0.15	216.62	16.01	150.82
GOD H007 64.5% SG	903	6.16	0.15	217.92	16.57	152.69
Pyrithiobac sodium 10% EC	62.5	6.09	0.15	216.39	15.72	149.01
Glyphosate 41% SL	820	6.13	0.15	217.41	16.15	152.29
Hand weeding	-	6.09	0.15	213.12	14.71	147.67
Weedy check	-	6.07	0.15	212.91	14.48	147.52
S.Em±		0.11	0.01	0.92	0.34	0.74
LSD (P=0.05)		NS	NS	2.83	1.04	2.28

Table 4: Effect of treatments on soil biological properties of wasteland soil before and after experiment

Treatment	Dose (g/ha)	Bacteria (CFU×10^5 /g of soil)	Fungi (CFU×10^4/g of soil)	Actinomycetes (CFU×10^4/g of soil)
GOD H007 64.5% SG	860	61.67	41.33	48.33
GOD H007 64.5% SG	882	62.67	44.67[a]	50.67[a]
GOD H007 64.5% SG	903	69.00[a]	48.00[a]	53.00[a]
Pyrithiobac sodium 10% EC	62.5	57.33	40.67	47.67
Glyphosate 41% SL	820	68.67[a]	47.67[a]	52.33[a]
Hand weeding	-	56.67	39.00	46.33
Weedy check	-	56.33	38.67	46.00
SEm±		2.41	1.28	0.86
LSD (P=0.05)		7.43	3.95	2.65

On the basis of the present investigation it can be concluded that this new herbicide product GOD H 007 containing glyphosate and pyrithiobac sodium can be used for effective control of weeds in non – cropped wastelands.

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