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Influence of Pre - and Post - Emergence Herbicides on Weeds and Yield of Dwarf Field Pea

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ABSTRACT

An experiment was conducted to evaluate the efficacy of different pre and post emergence herbicides on weed dynamics, weed density and yield of field pea during rabi season of 2010-2011 and 2011-12 at Pantnagar in tarai soil of Uttarakhand. Results revealed that Phalaris minor, Cyprerus rotundus and Argemone Mexicana were the pre-dominant weed species contributing 20.3, 16.1 and 15.8% of total population under weedy check condition respectively. It was observed that uncontrolled weeds caused 27.3 and 39.4% reduction in grain yield of dwarf fieldpea during first and second year, respectively as compared to two hand weedings done at 20 and 40 days after sowing (DAS). The highest weed control efficiency was recorded under two hand weedings followed by pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE, 30 DAS) and pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE, 30 DAS). Two hand weedings done at 20 and 40 DAS, which remained at par with pendimethalin1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE,30 DAS) and pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE, 30 DAS) caused significant reduction in weed population and produced 27.1, 23.1 and 16.0% more number of pods/plant and yielded 50, 40 and 35.7% higher grain yield, respectively over weedy check.

Key words: *Weed dynamics, Phalaris minor, Cyprerus rotundus, Argemone Mexicana, Pre-emergence, Post-emergence*

INTRODUCTION

The major weeds of field pea include *Cyprerus rotundus, Circium arvense, and Cynodon dactylon* as the common perennial weeds. *Chenopodium album, Polygonum plebejum, Vicia sativa, Melilotus alba, Solanum nigrum and Coronopus didymus, Fumaria parviflora, Phalaris minor, Lathyrus sativa* as common annual weeds of fieldpea under *tarai* condition of Pantnagar[9]. According to an estimate uncontrolled weeds in pea may cause yield reduction up to an extent of 64.4%[1]. Degree of yield reduction generally depends on the nature of crop, the weed species present, weed density and duration, stage of competition with crop and time of weed removal.

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In order to harness the yield potential of any genotype, it is imperative to provide a congenial weed free environment to the crop for certain period. Mechanical methods (intercultural practices) viz: hand weeding by *khurpi* and hoeing are principally aimed at destroying the weeds. These methods accomplish the job more efficiently but are labour intensive. Earlier, weed control through herbicides was considered costly, but chemicalization in agriculture has, however, offered a wide spectrum of herbicides which can accomplish weed control at much lower cost than mechanical and cultural methods. Many herbicides have been tested and recommended for weed control in field pea. These herbicides are applied either as pre-emergence or as pre plant soil incorporation. Recently a number of chemical formulations have been developed that can be used as post emergence. These post emergence applied chemicals may revolutionize the prospect of growing field pea which is severely infested by weeds after one month of sowing because of its slow initial growth. In fact the use of single herbicide may lead herbicide resistance and may cause shift in weed flora. Moreover, combination of one pre and another post emergence herbicides in pea may provide a complete control of weeds up to 45-50 days stage after which crop itself work as cover which may shift the competition in favour of crop. Keeping these points in view the present investigation was carried out.

MATERIALS AND METHODS

Field experiment was conducted during *rabi* season of 2010-11 and 2011-12 at N.E. Bourlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), situated at 29° N latitude, 79.3° E longitude and at an altitude of 243.84 metres above mean sea level. The soil of experimental area was sandy clay loam in texture with neutral in reaction (pH-6.7) having high organic carbon (1.18%), medium available nitrogen (288 kg N/ha), phosphorus (20 kg P/ha) and potassium (165.8 kg K/ha) contents. The experiment consisted of ten treatments viz. quizalofop ethyl 0.05 kg/ha (POE), quizalofop ethyl 0.06 kg/ha (POE), imazethapyr 0.05 kg/ ha (POE), imazethapyr 0.075 kg/ha (POE), chlorimuron ethyl 0.004 kg/ha (PPSI), pendimethalin 1.0 kg/ha (PE), pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE), pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE), two hand weedings at 20 and 40 days after sowing (DAS) and weedy check were set out in randomized block design with three replications. Chlorimuron ethyl was incorporated in top 5 cm surface soil, one day before sowing of crop. Pre-emergence (pendimethalin) herbicide was applied by spraying uniformly next day after sowing. The post emergence herbicides (imazethapyr and quizalofop) were applied after 30 days of sowing. Fieldpea crop (var. Pant P-14) was sown in rows 30 cm apart, on 16th and 18th November during 2010 and 2011, respectively by using 100 kg/ha seed rate. Crop was fertilized with 18 kg N, 48 kg P_2O_5 and 24 kg K_2O /ha using N, P, K mixture of (12:32:16) applied in rows uniformly at the time of sowing of crop. A total of 79.8 mm rainfall during 2010-11 and 37.0 mm during 2011-12 was received at experimental site during crop growing period. Herbicides were applied as per treatment in aqueous solution using 600 litres of water per hectare. The herbicide solution was sprayed uniformly and carefully with the help of Maruti foot sprayer having flat fan nozzle. Weed population was studied with the help of a quadrate (50cm×50cm) placed in second row in the different corners of the plot for different observations. The weeds falling within the quadrate were identified, counted species wise at 30 and 60 days after sowing. The total number of weeds/ m^2 was calculated by multiplying the population with a constant 4. The data recorded for each parameter were subjected to analysis for variance for randomized block design. Analysed data for each character were tabulated treatment wise and presented in results. Overall differences were tested for 'F' test at 5% level of significance.

RESULTS AND DISCUSSION

Weed species

Weed flora of experimental field were collected, identified and classified as sedges, grassy and broad leaf weeds. Out of 18 weed species identified, 3 species were predominant i.e. *Phalaris minor*, *Cyperus rotundus* and *Argemone mexicana* under weedy check condition for which per cent population is given in (Table 1). *Phalaris minor*, *Alopecurus myosuroides*, *Avena ludoviciana*, *Lolium temulentum* and *Vicia sativa* were found major weeds in experimental area in Himachal Pradesh[1].

The total weed density was found to be significantly different under different weed control treatments at all the stages of crop growth (Table 2). At 30 day stage of crop all treatments recorded significant reduction in weed flora compared to weedy check except imazethapyr 0.075 kg/ha (POE). Among different herbicides, all the treatments except imazethapyr 0.075 kg/ha (POE) reduced the weed population significantly over weedy check.

At 60 days stage of crop growth, all the treatments were found significantly superior to weedy check in respect of weed reduction. Pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE) recorded maximum reduction in weed density next to two hand weeding done at 20 and 40 days after sowing, quizalofop ethyl 0.05 kg/ha and pendimethalin caused the least reduction in weed population among herbicide treatments.

Phalaris minor was the most dominant weed, having share of about 20.3% at total density under weedy check condition. At 60 days crop stage, maximum density of *Phalaris minor* was recorded in weedy check treatment which decreased, there after till harvest (Table 2). Pre-emergence application of pendimethalin 1.0 kg/ha and pre plant soil incorporation of chlorimuron ethyl 0.004 kg/ha reduced the density of *Phalaris minor* at 30 days stage as compared to weedy check. At 60 days stage hand weeding twice at 20 and 40 DAS being at par with pendimethalin 1.0 kg/ha, chlorimuron ethyl 0.004 kg/ha, quizalofop 0.05 kg/ha and pendimethalin 1.0 kg/ha (PE)+ quizalofop 0.05 kg/ha recorded significantly more reduction in density of *Phalaris minor* than other weed control treatments and weedy check. At 90 days stage, among the chemical treatments pendimethalin 1.0 kg/ha + imazethapyr 0.05 kg/ha recorded maximum reduction in *Phalaris minor* density and was found next efficient to hand weeding. This treatment was at par with pendimethalin 1.0 kg/ha + quizalofop 0.05 kg/ha, pendimethalin 1.0 kg/ha, quizalofop 0.05 kg/ha and 0.06 kg/ha with respect to reduction in *Phalaris minor* density. Anil Kumar Mawalia *et al*.,[1] reported that Pendimethalin 1.0 kg/ha supplemented with one hand weeding at 45 DAS being statically at par to the application of pendimethalin 1.0 kg/ha (pre) followed by imazethapyr + imazamox 0.06 kg/ha (post) significantly reduced the density of major weeds.

Cyperus rotundus was the second dominant weed having a share of about 15.8% of the total weed population. Density of *Cyperus rotundus* was highest at 60 day stage of crop in weedy check and there after its density reduced till harvest (Table 2). Differences in density of *Cyperus rotundus* were recorded significant due to different treatments. At 30 days stage chlorimuron ethyl 0.004 kg/ha recorded the maximum reduction in *Cyperus rotundus* population and was at par with quizalofop 0.06 kg/ha+ imazethapyr 0.05 kg/ha and 0.075 kg/ha. At 60 days stage, all the post emergence treatments caused significant reduction in density of weed population over weedy check. The maximum reduction in *Cyperus rotundus* was recorded with imazethapyr 0.075 kg/ha next to hand weeding and was found at par with all the chemical treatments except pendimethalin 1.0 kg/ha. At 90 days stage, all the chemical treatments and two hand weedings caused significant reduction in *Cyperus rotundus* population over weedy check. Among the chemicals, the maximum reduction was observed under imazethapyr 0.075 kg/ha next to hand weeding treatment. Rana *et al*.,[6] found that *Phalaris minor*, *Avena fatua* and *Vicia sativa* were the

major weed flora in garden pea and post-emergence application of imazethapyr 100 and 150 g/ha at 20 and 40 DAS, quizalofop 37.5 g/ha at 20 DAS, isoproturon 1.0 and 1.25 kg/ha at 40 DAS and hand weeding twice resulted in significantly lower dry weight of weeds over pre-emergence pendimethalin 1.5 kg/ha.

At 30 days stage, none of the treatments was found to reduce population of *Argemone mexicana* significantly. However, two hand weedings proved superior to all other treatments. At 60 days stage all the weed control treatments recorded significant reduction in *Argemone mexicana* compared to weedy check. At 90 days stage, all treatments significantly reduced the population at *Argemone mexicana* in comparison to weedy check. All the herbicide treatments except quizalofop 0.05 kg/ha and Pendimethalin 1.0 kg/ha being at par among themselves recorded a significant reduction in *Argemone mexicana* population ever weedy check.

The density of other weeds, was influenced significantly by different weed control treatments at different stages of crop growth. The highest density of other weeds was recorded at 60 days stage of crop growth in weedy check. The share of other weeds at 30 and 60 DAS was 48.3 and 47.2% respectively. At 30 days stage, pre emergence of pendimethalin 1.0 kg/ha and pre plant soil incorporation of chlorimuron ethyl 0.004 kg/ha reduced the density of other weeds compared to weedy check. Pendimethalin 1.0 kg/ha recorded maximum reduction in the density of other weeds and found superior next to hand weeding done at 20 and 40 days after sowing. However, there was non significant difference between pendimethalin 1.0 kg/ha and chlorimuron ethyl 0.004 kg/ha in reduction of the density of other weeds.

At 60 days crop stage, imazethapyr 0.075 kg/ha recorded significant reduction in density of other weeds and was next to hand weeding. This treatment was at par with pendimethalin 1.0 kg/ha + imazethapyr 0.05 kg/ha, imazethapyr 0.05 kg/ha and pendimethalin 1.0 kg/ha (PE)+ quizalfop 0.05 kg/ha with respect to reduction in density of other weeds. The least reduction in population of other weeds was recorded under quizalofop 0.05 kg/ha and pendimethalin 1.0 kg/ha yet these were superior to weedy check. At 90 days stage pendimethalin 1.0 kg/ ha+ imazethapyr 0.05 kg/ha recorded significant reduction in other weeds population and was next to hand weeding done at 20 and 40 days after sowing. This treatment did not record significant difference with all other treatments. Pendimethalin 1.0 kg/ ha which recorded higher value of other weeds density and had non significant difference with weedy check.

Weed dry weight: All the weed control treatments reduced the dry weight of weeds significantly over unweeded check (Table 3). Magnitudes of reduction in dry weight of weeds varied significantly depending upon weed control measures adopted. The minimum weed dry weight was achieved in order of two hand weedings done at 20 and 40 DAS followed by pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE), pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE). Post-emergence application of imazethapyr 0.05 and 0.075 kg/ha controlled *Cyperus rotundus, Phalaris minor,* and *Argemone mexicana* to some extent for 60 days and provided a complete control up to harvest when combined with pendimethalin 1.0 kg/ha (Table.2). Endres *et al*.,[4] reported that pre-emergence application of imazethapyr 0.03 kg/ha+ pendimethalin 0.52 kg/ha provided 92% control of all weeds in fieldpea at Carrington. Application of pendimethalin 1.0 kg/ha (PE) was found more effective than other herbicides among single herbicides application treatments.

Weed control efficiency: All the weed control treatments employed, resulted in significant increase in weed control efficiency (WCE) over weedy check (Table 3). The maximum weed control efficiency was recorded under two hand weedings done at 20 and 40 days after sowing and was found significantly superior to others. Among the chemical treatments, application of pendimethalin 1.0 kg/ha (PE) + imazethapyr 0.05 kg/ha (POE)

recorded significantly higher WCE than remaining other chemical treatments. Quizalofop 0.05 kg/ha being at par with quizalofop 0.06 kg/ha and chlorimuron ethyl 0.004 kg/ha recorded weed control efficiency than others at 90 DAS. Rao *et al.*,[7] observed that the pre-emergence sand mix application of pendimethalin 1.0 kg/ha followed by sequential application of imazethapyr 0.05 kg/ha at 20 days after sowing recorded higher weed control efficiency (70 %) and higher seed yield than weedy check. The reduction in dry weight and high weed control efficiency under all weed control treatments over weedy check was due to reduction in weed density and individual dry weight of weeds by reducing their growth.

Yield attributes and grain yield

Yield attributes: Fieldpea sprayed with pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE, 30DAS) and pendimethalin 1.0 kg/ha (PE) + quizalofop ethyl 0.05 kg/ha (POE, 30 DAS) produced 27.8 and 23.3% more pods/ plant and 22.8 and 20.5% more grains per pod as compared to weedy check respectively (Table 4). This might be because of more number of grains per plant provided larger sink for photosynthesis. Moreover, due to less weed competition, crop plants might have got ample space for spreading their source (leaves) which trapped solar radiation more efficiently than remaining treatments and also enable to uptake more nutrients which ultimately reflected on yield. These treatments had a non significant difference with hand weedings done at 20 and 40 DAS which produced 27.8 and 22.8% more pods/plant and grains/pod over weedy check respectively. Different treatments were not able to cause significant difference on 1000 grain weight. Remarkable improvement in yield and yield attributes of pea due to different weed control treatments over weedy check were also reported by Wagner and Nadasy[10].

Grain yield*:* Two hand weedings done at 20 and 40 DAS yielded 37.7 and 65.0 % higher grain yield over weedy check during first and second year, respectively (Table 4). Increased grain yield under hand weedings done at 20 and 40 DAS might be due to favourable soil condition. Cultural practices like two hand weedings conditioned the soil for aeration, decreased bulk density and removed the weeds effectively, which in turn reflected on nutrient uptake and growth of plant. Increase in the grain yield of pea under hand weedings was also reported by Mishra[3] and Bindra *et al*.[5]. During first year i.e. 2010-11, two hand weedings done at 20 and 40 DAS being at par with the treatments quizalofop ethyl 0.05 kg/ha (POE, 30 DAS), quizalofop ethyl 0.06 kg/ha (POE, 30 DAS), imazethapyr 0.075 kg/ha (POE), pendimethalin1.0 kg/ha (PE), pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE, 30 DAS)and pendimethalin1.0 kg/ha (PE) +imazethapyr 0.05 kg/ha (POE). However, during second year i.e.2011-12, pendimethalin 1.0 kg/ha (PE)+ quizalofop ethyl 0.05 kg/ha (POE, 30 DAS), pendimethalin 1.0 kg/ha (PE)+ imazethapyr 0.05 kg/ha (POE) and hand weedings done at 20 and 40 DAS were found at par with each other and recorded significantly higher over weedy check and other treatments. On an average, pendimethalin 1.0 kg/ha , pendimethalin 1.0 kg/ha (PE) + quizalofop 0.05 kg/ha (POE), pendimethalin 1.0 kg/ha+ imazethapyr 0.05 kg/ha (POE) and two hand weedings at 20 and 40 DAS recorded 26.0, 24.8, 26.0 and 37.7% higher grain yield over weedy check.

Samuel[8] observed that post-emergence application of quizalofop p-ethyl 0.068kg ha-1 gave good control of perennial and annual grassy weeds such as wild oats, volunteer cereals, and other weeds and he also reported that imazethapyr (0.054 kg ha-^{1}) was is the most widely used herbicide to control broadleaf weeds in pea. Among the single application, pendimethalin 1.0 kg ha-1 and imazethapyr 0.05 kg ha-1 (POE), performed better during both the years. During second year more yield was recorded, which may be due to more favorable condition for the crop.

Table 1: Per cent composition of the major weeds species in weedy check treatment at different stages of crop growth (2010-11)

Days after sowing (DAS)	*Phalaris minor*	*Cyperus rotundus*	*Argemone mexicana*	Others
30	18.0	18.3	15.9	48.3
60	18.4	15.9	18.6	47.2
90	15.3	17.8	15.9	46.9
120	29.6	12.2	13.0	45.9
Mean	20.3	16.1	15.8	47.2

Table 2: Density of major weeds (plants/ m^2) as affected by different treatments at various stage of crop growth

Treatments	*Phalaris minor*			*Cyperus rotundus*			*Argemone mexicana*			Other weeds		
	Days after sowing (DAS)											
	30	**60**	**90**	**30**	**60**	**90**	**30**	**60**	**90**	**30**	**60**	**90**
Quizalofop ethyl @ 0.05 kg/ha (POE)	20.0	16.0	14.4	28.0	22.4	20.0	17.2	21.2	17.2	66.4	82.4	40.0
Quizalofop ethyl @ 0.06 kg/ha (POE)	24.0	24.0	18.4	17.2	24.0	14.4	9.2	14.4	10.4	80.0	76.0	34.4
Imazethapyr @ 0.05 kg/ha (POE)	22.4	30.4	25.2	24.0	18.4	13.2	9.2	12.0	8.0	74.4	61.2	42.4
Imazethapyr @ 0.075 kg/ha (POE)	32.0	30.4	18.4	17.2	16.0	8.0	21.2	13.2	9.2	97.2	48.0	24.0
Chlorimuron ethyl @ 0.004 kg/ha (PPSI)	21.2	17.2	18.4	13.2	20.0	21.2	12.0	16.0	9.2	69.2	76.0	29.2
Pendimethalin @ 1.0 kg/ha (PE)	25.2	13.2	12.0	18.4	37.2	17.2	14.4	12.0	21.2	54.4	78.4	48.0
Pendimethalin @ 1.0 kg/ha (PE)+ Quizalofop ethyl @ 0.05 kg/ha (POE)	14.4	10.4	14.4	20.0	22.4	20.0	17.2	13.2	10.4	66.4	60.0	25.2
Pendimethalin @ 1.0 kg/ha (PE)+ Imazethapyr @ 0.05 kg/ha (POE)	16.0	25.2	9.2	21.2	18.4	14.4	12.0	12.0	5.2	64.0	49.2	21.2
Hand weeding-20& 40DAS	16.0	10.4	8.0	18.4	5.2	5.2	8.0	2.4	13.2	34.4	21.2	25.2
Weedy check	36.0	48.0	34.4	36.0	41.2	38.4	32.0	48.0	36.0	97.2	122.4	106.4
S.Em.±	4.1	3.2	4.9	3.4	4.0	4.4	4.2	2.8	4.0	6.5	8.0	8.0
CD at 5%	12.1	9.4	14.5	9.7	13.0	13.0	NS	8.2	11.8	19.2	23.8	24.0

PE, Pre-emergence, POE, Post-emergence, PPSI, Pre Plant Soil Incorporation, DAS, Days after sowing

Table 3. Effect of different treatments on weed dry weight and weed control efficiency (Pooled data of two years)

Treatments	Weed dry weight (g/ m^2)		Weed control efficiency (%)	
	Days after sowing		Days after sowing	
	60	90	60	90
Quizalofop ethyl 0.05 kg/ha (POE, 30 DAS)	20.8	44.0	43.0	24.4
Quizalofop ethyl 0.06 kg/ha (POE, 30 DAS)	18.4	38.0	49.6	26.8
Imazethapyr 0.05 kg/ha (POE, 30 DAS)	18.9	41.2	48.2	31.3
Imazethapyr 0.075 kg/ha (POE)	13.2	32.8	63.8	39.4
Chlorimuron Ethyl 0.004 kg/ha (PPSI)	15.7	36.3	57.0	25.9
Pendimethalin 1.0 kg/ha (PE)	14.9	22.6	59.2	58.7
Pendimethalin 1.0 kg/ha (PE)+ Quizalofop ethyl 0.05 kg/ha (POE, 30 DAS)	8.13	19.3	77.7	64.0
Pendimethalin1.0 kg/ha (PE)+Imazethapyr 0.05 kg/ha (POE)	8.00	14.4	78.0	73.0
Hand weedings-20 & 40 DAS	2.93	5.6	92.0	89.6
Weedy check	36.5	54.0	0.0	0.00
CD (P=0.05)	4.4	6.5	7.1	9.2

PE, Pre-emergence, POE, Post-emergence, PPSI, Pre Plant Soil Incorporation, DAS, Days after sowing

Table 4: Effect of different treatments on yield attributes (Pooled data of two years) and grain yield

Treatments	Pods/ plant	Grains/ Pod	1000 grains weight(g)	Grain yield (kg/ ha)		
				2010-11	2011-12	Mean
Quizalofop ethyl 0.05 kg/ha (POE, 30 DAS)	16.3	6.00	150.0	2306	2264	2285
Quizalofop ethyl 0.06 kg/ha (POE, 30 DAS)	16.0	6.60	148.7	2333	2291	2312
Imazethapyr 0.05 kg/ha (POE, 30 DAS)	17.6	6.56	146.4	2250	2222	2236
Imazethapyr 0.075 kg/ha (POE)	14.6	6.10	145.6	2361	2403	2382
Chlorimuron Ethyl 0.004 kg/ha (PPSI)	15.0	6.20	149.0	2056	1875	1965
Pendimethalin 1.0 kg/ha (PE)	18.0	6.61	149.3	2385	2222	2312
Pendimethalin 1.0 kg/ha (PE)+ Quizalofop ethyl 0.05 kg/ha (POE, 30 DAS)	17.4	6.62	149.0	2375	2583	2479
Pendimethalin1.0 kg/ha (PE)+ Imazethapyr 0.05 kg/ha (POE)	18.6	6.70	146.2	2403	2708	2555
Hand weedings-20 & 40 DAS	19.3	6.83	149.0	2621	2889	2755
Weedy check	15.1	5.56	147.7	1903	1750	1826
CD (P=0.05)	2.81	0.47	NS	319	412	365.5

PE, Pre-emergence, POE, Post-emergence, PPSI, Pre Plant Soil Incorporation, DAS, Days after sowing

CONCLUSION

From the above, it can be concluded that pendimethalin as pre-emergence @ 1.0 kg/ha followed by imazethapyr or quizalofop ethyl @ 0.05 kg/ha at 30 DAS or hand weeding at 20 and 40 DAS are equally effective in terms of weed control and realizing seed yield in fieldpea in *tarai* soil of Uttarakhand.

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