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Research Article

Efficacy of Fungicides Against Powdery Mildew (*Pseudoidium jatrophae*) of Physic Nut (*Jatropha curcas L.*) at Alage and Koka Districts of Ethiopia

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ABSTRACT

Powdery mildew caused by the fungus (*Pseudoidium jatrophae*) was previously described as *Oidium heveae* Stein by Viégas in Brazil. In Ethiopia, physic nut loses its economic part, like oil content and quality due to powdery mildew disease. Thus, the present study was conducted during the cropping seasons of 2016 and 2017 at Alage and Koka experimental fields to test the efficacy of different fungicides in controlling powdery mildew diseases of physic nut. Results revealed that tebuconazole recorded the highest reduction of powdery mildew disease severity after 1st, 2nd and 3rd sprays of fungicides and was found significantly superior as compared to other tested fungicides followed by Triadimefon (Noble 25 WP). The highest percent disease severity was recorded in the untreated control plot. In general, all the fungicide treatments significantly reduced the severity of the disease more than control.

Keywords: Efficacy; Fungicides; Physic nut; Powdery mildew; Severity

INTRODUCTION

Physic nut (*Jatropha curcas L.*) is a perennial deciduous shrub belonging to the family Euphorbiaceous; which is native to Central America and Mexico and naturalized throughout the tropics and subtropics. Its genus contains approximately 170 known species and has many characteristics such as its hardiness, rapid growth, easy propagation, and widely ranging usefulness that led to its spread by the Portuguese traders as a valuable hedge plant and an oil yielding species. Therefore, it is grown on many continents such as Latin America, Asia, and Africa aiming to produce biodiesel. In Eastern Africa, it is cultivated as a hedge, for erosion control, exclusion of animals from food crops and demarcation of properties, particularly farmland [1].

The physic nut plant can adapt to a wide range of environmental conditions and can survive to a minimum of 250 mm to 300 mm of rainfall but requires at least 600 mm flowering and producing seed. The optimum temperature required ranges between 20°C to 28°C while the best soils are aerated sands and loams of at least 45 cm depth and waterlogging should be avoided. It is known for its ability to survive in very poor dry soils, in marginal conditions for agriculture but survival abilities do not mean that high productivity can be obtained in marginal environments [2]. In Ethiopia, the physic nut is grown traditionally for the same purposes mentioned above and found abundantly in different areas such as in Southern nations nationalities and people region (Gamo Goffa, Gurage, Hadiya, Silte, Sidama), in Amara region (Gojjam areas, Bati, Shoarobit, Matamma), in Tigray region (Alamata, Kola Tenben, central), in Benshangumiz region (Metekel) and Oromia (Adama areas, Kelam Wallaga, East Wallaga, East and West Hararge, Jimma, Borana, Bale and Illuabora.

Despite the existence of wide agro-ecology in Ethiopia for physic nut plants, several biotic and abiotic constraints limit its production reported that pests can cause up to 57% damage to physic nut. The attack by pests and diseases is a limiting factor in achieving optimum production, especially under sole monocultures, where pests and disease control may become inevitable. Powdery mildew caused by the fungus (*Pseudoidium jatrophae*) was previously described as *Oidium heveae* Stein by Viégas in Brazil. The disease widely occurs in physic nut plantations and it has been frequently seen in various regions of Brazil and the rest of the world. Oidium species have been found to attack physic nut in Kenya, with nationwide distribution. In Ethiopia, the prevalence of several pests on physic nut was reported by Negasu. Among which powdery mildew was the most important disease found on physic nut plant which caused 97% and 62.60% incidence and severity, respectively [3].

The most common symptoms of the disease are the production of abundant white or gray mycelia in leaves, petioles, stems, flowers, and fruits. With the evolution of the disease, infected plants may show

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necrotic lesions, which cause leaf fall, underdevelopment, death of buds, and young fruit deformation. The fungus that causes this disease is a typical biotrophic pathogen of the phylum Ascomycota, order Erysiphales. This pathogen may be characterized by white or grayish colonies, septate and branched mycelia; conidiophores that are erect or ascending, cylindrical, hyaline, septate, and forming conidia singly; conidia that are usually large in proportion to the diameter of the conidiophores, simple, smooth, ellipsoid-ovoid deiform, hyaline, single-celled. The disease generally favors warm temperatures, the humidity of 75%-80%, and reduced light. Heavy rains are generally unfavorable to the pathogen. In Ethiopia, physic nuts lose their economic part, like oil content and quality due to powdery mildew disease. Therefore, this study aimed to evaluate the efficacy of fungicides to control powdery mildew on physic nut plants under field conditions [4,5].

MATERIALS AND METHODS

The experiment was conducted in Alage and Koka districts of Ethiopia under natural field conditions during in 2016 and 2017 cropping seasons. The experimental was laid out in a randomized complete block design with three replications and consisted of six treatments Triadimefon (Bayleton 25 WP), Triadimefon (Noble 25 WP), Trifloxystrobin 100 gm/lit +Tebuconazole 200 gm/lit (Nativo SC 300), Bupirimate (Nimrod 25 EC), Tebuconazole (Bless and control) [6-12].

Disease severity

Disease severity data were recorded three times for each treatment with one before the application of fungicides. The time interval was maintained as 15 days. The first spray of fungicides as per treatments was taken up after the initial appearance of disease in the crop and further sprays were given at 15 days interval with a knap sack sprayer (15 liters in capacity) of spray fluid per plot for thorough coverage of foliage with spray fluid [13-19]. The severity of powdery mildew was recorded one day before the second and third spray from the central rows of the plot and on each plant, assessment was made before and after treatments application on stem, leaf, petiole, and fruit, and finally 10 days after the third spray. After each observation, their mean percentage was calculated by using following formulae using rating scale of 0-4 points where 0=0% healthy plant, 1=1%–25%; 2=26%–50%; 3=51%-75%; 4=76%–100% leaf areas infected:

$$Disease\ Intensity(\%) = \frac{Sum\ of\ all\ numerical\ rating}{Total\ number\ of\ leaves\ rated\ \times\ maximum\ disease\ grade} \times 100$$

Additionally, the efficacy of each fungicide was calculated by using the formula developed.

$$Efficacy(\%) = \frac{X - Y}{X} \times 100$$

Where X-Disease severity of the control, Y-disease severity of the treatment.

Data analysis

All collected data were subjected to Analysis of Variance (ANOVA) using SAS software version 9.4. Wherever treatment differences are found significant, the mean separation of treatments would be calculated based on the results of the F-test and probability levels of 0.05 depending on the results of the ANOVA [20-29].

RESULTS AND DISCUSSION

The present results revealed that significant variation was observed among tested treatments after 1st, 2nd, and 3rd sprays. After 1st spray, non-significant variation was observed on treated plots except plots treated with treatment Bupirimate and Trifloxystrobin 100 gm/lit+Tebuconazole 200 gm/lit. The lowest disease severity was obtained from the treatment Triadimefon (Noble 25 WP) (2.01%) (Table 1). After 2nd spray, the lowest disease severity was obtained from treatment Triadimefon (Noble 25 WP) (0.88%) followed by treatment Tebuconazole (1.04%). After 3rd spray, the lowest disease severity was recorded from treatment Tebuconazole (1.95%) followed by treatment Triadimefon (Bayleton 25 WP) (2.41%). Overall, the lowest value of disease severity was recorded from treatment Tebuconazole (2.60%) followed by Triadimefon (Noble 25 WP) (2.97%). In all spraying intervals, the effect of tested treatments was significantly observed in a reduced rate of disease intensity (severity); however, some tested treatments were not significantly reduced. Thus, treatment Tebuconazole followed by Triadimefon (Noble 25 WP) significantly reduced the disease severity in all spraying intervals. Similarly, Prakash and Raoof reported that Carbendazim was highly effective against powdery mildew when sprayed three times at the interval of 15 days. Also, Haq recommended the use of Penconazole and Thiophanate methyl for the control of powdery mildew of mango.

Table 1: Overall mean percent of disease severity (%) after treatments application over the location.

Treatment	After			
	1st spray	2nd spray	3rd spray	Mean
Triadimefon (Bayleton 25 WP)	2.04^{c}	2.02^{c}	2.41^{cd}	3.37^{d}
Triadimefon (Noble 25 WP)	2.01^{c}	0.88^{d}	3.98^{b}	2.97^{e}
Trifloxystrobin 100 gm/lit +Tebuconazole 200 gm/lit	2.73^{b}	3.45^{b}	3.82^{b}	4.78^{b}
Bupirimate	3.00^{b}	2.30^{c}	3.13^{bc}	4.11^{c}
Tebuconazole	2.18^{c}	1.04^{d}	1.95^{d}	2.60^{e}
Control	4.95^{a}	5.90^{a}	8.28^{a}	6.52^{a}
Lsd0.05	0.55	0.47	1.18	0.39
CV (%)	16.18	15.10	25.04	7.93

Note: ^{a}: The highest treatment; ^{e}: The lowest treatment. The intermittent alphabets (b, c and d) indicate the treatment in the descending order.

Interaction effects of fungicides and location excreted a significant influence on disease severity after treatments application under field conditions. In all after spraying intervals, the highest disease severity was recorded in untreated plots at both locations. The overall mean of disease severity data indicated that the lowest value was found in treatment Tebuconazole (1.89%) followed by Triadimefon (Noble 25 WP) (1.96%) at location two (Table 2). This indicates performance inconsistency of fungicides in varied environments; hence, a wider agro-ecological test trial is inquired to evaluate these fungicides. In agreement with the present study, Fehr reported that every factor that is a part of the environment of a plant has the potential to cause differential performance. Likewise, Frankel and IRRI reported that fluctuating features of the location such as rainfall, relative humidity, temperature, etc. are some of the environmental factors that cause performance variation in plants.

The location had a significant influence on the disease severity after fungicides application. In 1st and 3rd sprays, the higher disease severity was in location one (4.24%) and (6.70%), respectively. The higher overall mean of disease severity was also found in location one (5.08%) (Table 3). This indicates this parameter was influenced by a change in the environment. The significance of the location effect was expected because Alage and Koka vary in their rainfall, temperature, and other environmental factors.

The present results revealed that the efficacy of each applied fungicide was also computed after each treatment application. The highest efficacy was recorded from treatment Triadimefon (Noble 25 WP) (59.39%) followed by treatment Triadimefon (Bayleton 25 WP) (58.79%) while the lowest was from treatment Bupirimate (39.39%) after 1st spray. After 2nd spray, the highest efficacy was recorded from the treatment Triadimefon (Noble 25 WP) (85.08%) followed by the treatment Tebuconazole (76.45%). After 3rd spray, the highest efficacy was recorded from treatment Tebuconazole (82.37%) followed by treatment Triadimefon (Bayleton 25 WP) (70.89%). The highest overall mean of efficacy was recorded in the treatment Tebuconazole (60.12%) followed by Triadimefon (Noble 25 WP) (54.45%) (Figure 1). Therefore, Tebuconazole (60.12%) treatment was more effective than other tested fungicides for the management of powdery mildew on physic nut plants under field conditions. Gupta and Shyam observed the efficacy of Triademefon, Hexaconazole, Difenaconazole, Flusilazole, Fenarimol, Penconazole, Mancozeb, and Chlorothalonil, among these Hexaconazole (0.10%) and Difenoconazole (0.01%) were best against powdery and increased yield. Ransom, Alam and Loganathan have reported the role of triazoles like tebuconazole, Propiconazole, and Flusilazolein in managing the pea powdery mildew and increasing the pod yields. Hexaconazole has been reported to be effective against pea powdery mildew by Gupta and Shyam. Jarial and Sharma have also reported Hexaconazole and Carbendazim to be effective against the disease and increase the pod yield and other yield parameters correspondingly.

Table 2: The interactions effect of treatments and locations on disease severity after sprays.

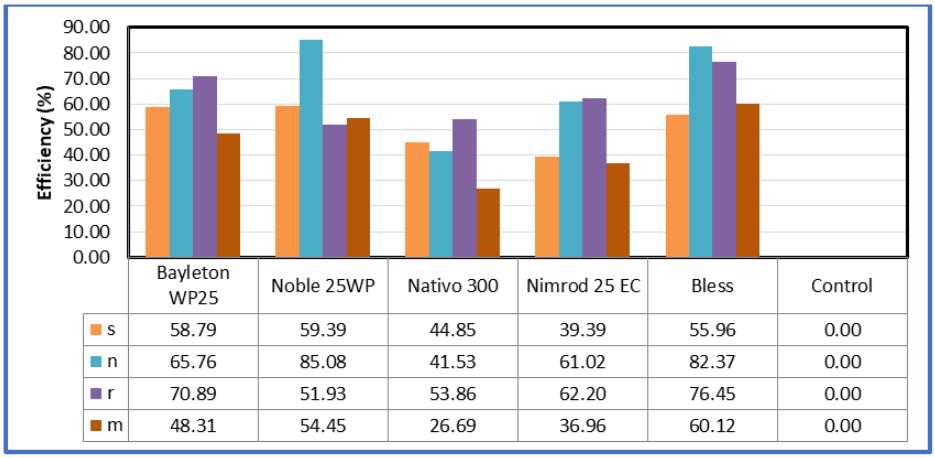
Treatment	After							
	1st spray		2nd spray		3rd spray		mean	
	Alage	Koka	Alage	Koka	Alage	Koka	Alage	Koka
Triadimefon (Bayleton 25 WP)	2.55^{d}	1.58^{f}	0.95^{ef}	3.09^{d}	4.44^{cd}	0.38^{gh}	3.67^{ef}	3.07^{g}
Triadimefon (Noble 25 WP)	2.44^{de}	1.53^{f}	1.17^{ef}	0.59^{f}	7.78^{b}	0.18^{h}	3.99^{de}	1.96^{h}
Trifloxystrobin 100 gm/lit+ Tebuconazole 200 gm/lit	3.94^{c}	1.52^{f}	4.31^{c}	2.59^{d}	5.77^{c}	1.88^{fg}	5.98^{b}	3.57^{efg}
Bupirimate	5.01^{b}	1.00^{f}	1.60^{e}	3.00^{d}	4.56^{cd}	1.69^{fgh}	4.84^{c}	3.37^{fg}
Tebuconazole	3.35^{c}	1.00^{f}	0.94^{ef}	1.13^{ef}	3.78^{de}	0.11^{h}	3.32^{fg}	1.89^{h}
Control	8.15^{a}	1.75^{ef}	6.52^{a}	5.28^{b}	13.85^{a}	2.71^{ef}	8.70^{a}	4.34^{cd}
Lsd0.05	0.78		0.66		1.67		0.54	
CV (%)	16.18		15.10		25.04		7.93	

Note: [a]: The highest treatment; [h]: The lowest treatment. The intermittent alphabets (b, c, d, e, f, and g) indicate the treatment in the descending order.

Table 3: The effected locations of powdery mildew of physic nut.

Location	Mean severity (%) After		
	1st spray	3rd spray	mean
Alage	4.24^{a}	6.70^{a}	5.08^{a}
Koka	1.40^{b}	1.16^{b}	3.03^{b}
Lsd0.05	0.32	0.68	0.22
CV (%)	16.18	25.04	7.93

Note: [a]: The highest treatment; [b]: The lowest treatment.



	Bayleton WP25	Noble 25WP	Nativo 300	Nimrod 25 EC	Bless	Control
s	58.79	59.39	44.85	39.39	55.96	0.00
n	65.76	85.08	41.53	61.02	82.37	0.00
r	70.89	51.93	53.86	62.20	76.45	0.00
m	48.31	54.45	26.69	36.96	60.12	0.00

Figure 1: The Percent of Fungicides Efficacy on Powdery Mildew After 1st, 2nd and 3rd Sprays and Overall Mean. **Note:** ( ) s=1st spray; ( ) n=2nd spray; ( ) r=3rd spray; ( ) m=overall mean.

CONCLUSION

The present study concluded that spraying of Tebuconazole and Triadimefon (Noble 25 WP) were highly effective in controlling the severity of powdery mildew disease of *Jatropha curcas* in field conditions. Those selected fungicides showed varying levels of antifungal activity against *Jatropha curcas* powdery mildew but there was better than untreated treatment.

CONFLICTS OF INTEREST

The work described has not been published previously, nor is it under consideration for publication elsewhere. All authors approve publication, all sources of funding and reference are duly acknowledged, and no conflicts of interest are applicable.

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